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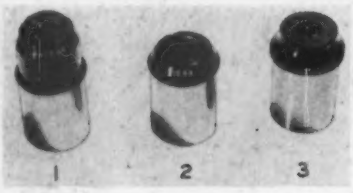

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MORE ON THE ECLIPSE COMET OF 1948

From *The Observatory* of December, 1948, we quote part of the proceedings of the meeting of the Royal Astronomical Society held on November 12th, at which Dr. R. d'E. Atkinson told something of his recent eclipse expedition to East Africa, and the discovery of the comet during the eclipse. (*Sky and Telescope*, January, 1949, page 59.) Dr. Atkinson said:

"I propose to speak mainly about the comet which was observed during the eclipse; as far as our own eclipse observations are concerned, I believe they were successful, but the films have not yet been developed.

"The comet, though very bright, was not visible at Mombasa, where we were (98% totality), but several newspaper reports from further north referred to it; they did not sound very convincing. A photograph was published, but as printed it did not actually show the comet; the accompanying description was also based on an error, as I later learnt. On the journey to Nairobi, sixty hours after the eclipse, I spoke to an eye-witness, whose account disagreed with that in the paper. It was not until I had seen the photographs taken by the R.A.F. at Nairobi, and had found that they agreed with eye-witness reports at both places, that I realised it must have been a comet; I then made a very rough measurement of its place on the R.A.F. film, and telegraphed Dr. Merton. As a result of my interest in these photographs, which were taken at 13,000 feet just within and just outside the shadow, the Air Commodore very kindly let me bring the films home for thorough examination. [On one picture] very much enlarged from a hand-camera snapshot also taken by a member of the crew . . . the tail is clearly visible; visual observers all agreed that it extended downwards until it reached either clouds or the horizon, and it must have been twenty degrees long at least. The visible part of it does not point away from the Sun at all; any portion which does this must have been extremely foreshortened. [On another picture] the scale is larger and the definition

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MARCH, 1949

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BACK COVER: The diffuse nebula NGC 1977, in Orion, photographed by the 100-inch telescope on January 7, 1921. This nebula is north of the Great Nebula in Orion. Mount Wilson photograph. (See In Focus.)

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Clyde Fisher's picture of himself and the former director of Yerkes Observatory, the late Dr. Edwin B. Frost. American Museum of Natural History photograph.

CLYDE FISHER

Naturalist and Teacher

BY MARIAN LOCKWOOD

Formerly Associate and Acting Curator of the Hayden Planetarium

HE LIKED MOST OF ALL to be called a teacher — and he was a born teacher — this man whose great thatch of curly white hair was a familiar sight in the long halls of the American Museum of Natural History, on the streets of New York City, and on the roads and by-ways of the nearby countryside. Clyde Fisher was a teacher by temperament and a scientist by training, a man whose two great passions were people and a reverence for scientific truth.

He could not abide either loose generalizations or overdramatic presentations of the truths that make up the great body of science. I have heard him many times arguing doggedly over what he considered unwarranted and misleading interpretations of the facts. "Stick to the facts," he would say. "Yes, of course, this interpretation might be true, and then again it might not. Don't present it as true, then, even though it *may* possibly be so. Not until you're sure." He never succumbed, as do some scientists and teachers, to the temptation to make the facts of science more spectacular than they really were.

In spite of all this, Clyde Fisher was not a technically minded man. He was a popularizer largely because of his real liking for people of all kinds. His great interest was in presenting the facts — whether about flowers, rocks, or stars and planets — so that they might exert their own peculiar fascination upon other people as they did upon him. He was a great teacher because of his own enthusiasm and knowledge, and because of his interest in others. His life was made up of people, many people, and he never became too old or too tired, up to the very last, to find stimulus and interest in the human beings around him. But this was not because he found them an interesting psychological study — he never thought of people in terms of psychology — but rather because he reacted to them directly, as they did to him.

Dr. Fisher loved children and especially delighted in discovering and drawing out their interests and their points of view. Indeed, one of his greatest charms was his own almost childlike wonder at the mysteries and intricacies of nature's work. When he was lecturing in the Copernican Hall of the Hayden Planetarium, as he did so many thousands of times, he would take infinite care in answering the many difficult or even silly questions that might be asked of him. I have often seen him spend long minutes in the big hall trying to make clear to a small boy of seven or eight the difference, for instance, between planets and stars, or why the days are longer in summer than they are in winter. He had the greatest respect for the inquiring intelligence of the child. He often remarked that he had more frequently been "put up a tree" by children's questions than by those of adults. There was no child who could ask a question too simple or too complicated for his patience to cope with, and never did I see him turn away from any honest seeker after truth. Hour after hour he would talk to visitors in his office in the planetarium, or stand in the doorway to the planetarium dome patiently answering the numerous questions of those who had just emerged from the star chamber. Many a younger scientist or curator who worked with him remembers, too, with deep gratitude, his ever lively willingness to help, to coach, and to explain when the going was tough.

Although he was probably best known by the great majority of people as the man who made the heavens roll around, much of his early work was done directly in the field of education. In his

While Jackie Geiger looks on, Dr. Fisher starts a Foucault pendulum in an exhibition hall of the American Museum of Natural History.

At night the facade and exterior dome of the Hayden Planetarium in New York City are illuminated. As the visitor enters the main first floor hall he faces a large mural, designed by Dr. Fisher and Dr. Clark Wissler to portray the astronomical mythology of the Blackfoot Indian, and painted by Charles R. Knight. American Museum photographs.

younger days he was principal of Palmer College Academy, of which he was acting president in 1909 and 1910. Later he was an instructor at Cornell University and in the universities of Florida and Tennessee. In 1913 Dr. Fisher became curator and head of the department of education at the American Museum of Natural History. He held that post until 1933. His ideas on education were progressive in the extreme. Dr. Roy Chapman Andrews wrote of him that his "progressive views on child education formed the cornerstone of modern visual education that has been a model for museum education throughout the country." To those who knew him well, and to those who studied under him, it seemed that his main desire was to make learning about natural history *fun*. Teaching and lecturing were never work for him.

I gained a great deal of insight into Dr. Fisher's methods and approach to his students when I first took over one of his New York University classes in astronomy at a time when he was on an extended lecture trip. As the class hour progressed, I noticed that most of the students had their textbooks open in front of them. They were answering my questions directly from the book. I demurred at this, but soon came to understand that Dr. Fisher's way was to explore with the students the text in front of them, for he cared nothing for discipline or for memorizing by rote. His own enthusiasm, his never-failing zeal for learning to unlock the doors of nature's mysteries, were communicated directly to his students. In his mind there was nothing more exciting for any boy or girl, man or woman, than to *learn* — whether it was to discover why Mars is red or why a snake sheds its skin.

Born on a small farm near Sidney, Ohio, Clyde Fisher lived during his early years the life of any farm boy, with this difference — that he always recognized in the natural objects around him the marvelous hand of nature. To him a rock was not just a rock — it carried in its unpretentious being the whole history of the earth on which he lived. A flower, exquisite to his eyes, was an intricate and somewhat mysterious organism which he was determined to understand.

As he grew older, he developed an intense interest in botany, and it was in this science that he took his Ph.D. at Johns Hopkins University. In time, however, astronomy came to be his real love. It was through his devoted and unremitting efforts that the Hayden Planetarium was at last brought to New York City. He went to Europe and visited various planetariums, with the purpose of persuading the authorities of the American Museum to install a planetarium there. His joy and his delight in the accomplishment of this dream were infectious, and all of those who worked with him during the early years of the Hayden Planetarium's history were spurred on and invigorated by his confidence in the importance of bringing the stars to people.

The Optical Division of the Amateur Astronomers Association has its workshop in the basement of the Hayden Planetarium. Dr. Fisher is here comparing a 21-inch mirror blank and a 4¼-inch rich-field telescope. Photo by Robert E. Cox.

Dr. Fisher lectured not only in the planetarium and in the American Museum, but on lecture platforms throughout this country and abroad. His striking appearance, his beautiful voice, and his genial manner combined to produce the perfect platform personality, carrying with it the authenticity of the true scientist.

A man like this could hardly be a cloistered spirit. And indeed, he had the greatest genius for making friends. His numerous close friends were among people who were just the plain garden variety of human beings, as well as among the most illustrious and talented. John Burroughs, whom he greatly admired, he knew very well. Einstein, Eddington, Jeans, John Kieran, and Ernest Seton-Thompson, and the young people in the Amateur Astronomers Association, each held a particular place in his affections. His home — with his second wife, the Princess Te Ata of the Chickasaw Nation — was the gathering place for multitudes of friends, for good talk and jolly evenings.

Often, on a hot summer's afternoon, he would come out of his office with a somewhat sheepish expression on his face. "I'm going to knock off today," he'd say, "and take a couple of the boys to the baseball game." Sometimes the "boys" were fellow curators in the museum, or as likely as not they were two of the museum attendants or office boys. No one ever had a better time than he did, whether at a baseball game or photographing an eclipse of the sun above the clouds.

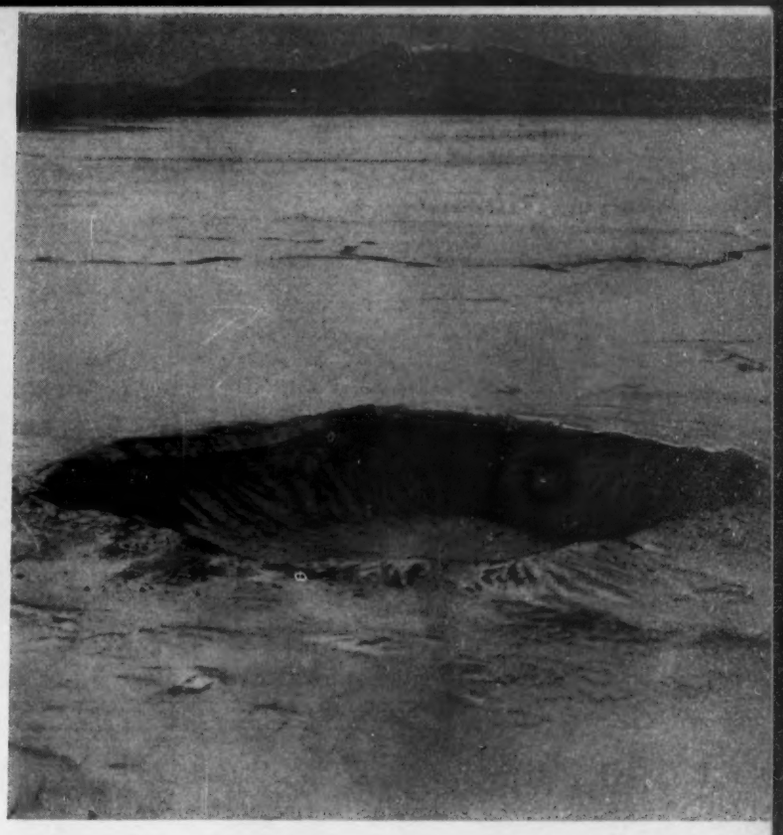
It could hardly be otherwise than that a man with such an inquiring mind and such *elan vital* should be fascinated with exploring. He was always setting forth on expeditions to see and experience something new of life, whether it happened to be an expedition to Arctic Lapland or Peru, or to one of the foreign restaurants in New York City where he delighted to take many of his friends.

Among his numerous expeditions were two trips to Arctic Lapland where he became a friend of the great Lappish writer, Johan Turi. Because his inter-

est in American Indians had always been great, he made a number of trips into the southwest where he made many Indian friends. Long Lance, Oskenonton, Marie the famous potter, and others, came to call this white man their friend. In 1927 he was adopted into the Sioux tribe of North Dakota and was given the name of one of their most illustrious chiefs, Mato-koki-popi. He was proud of being a member of the Sioux tribe, but when asked what his name meant, he would always make a wry face. Mato-koki-popi means "Afraid-of-Bear," a name which reflected not at all on the original owner of the name, nor on Dr. Fisher. When a little boy, the chief had been badly scared by a bear, and thereafter his name was connected with that incident.

As a member of the Harvard-Massachusetts Institute of Technology eclipse expedition, Dr. Fisher went to Siberia in 1936; as leader of the American Museum eclipse expedition, he went to Peru in 1937; and recently he visited Mexico twice to study the volcano Paricutin. In addition, he several times flew above the clouds to study and photograph eclipses of the sun.

Dr. Fisher was an inveterate and extremely skillful photographer. With his heavy Graflex on his back, he climbed mountains, explored in far places, and took pictures both for his personal pleasure and for professional purposes. His collection of colored flower photographs is probably not surpassed. Among his interests was the famous Meteor Crater in Arizona, which he photographed many times from the air and from the ground. His charm and his friendly personality enabled him to persuade airplane pilots and Indians, world-famous scientists and mothers with babies, to help him take unusual photographs.



From an airlines plane, Dr. Fisher took this picture of Meteor Crater, Arizona, in the winter. American Museum of Natural History photograph.

At the memorial service held for Dr. Fisher in the Little Church Around the Corner on January 9th, his friends were present in large numbers. Among them were curators from various museums, explorers, writers, artists. And there, afterwards, standing on the walk outside the church, I talked with the devoted woman who had for years cleaned house for him and Te Ata. To her he was simply "my Dr. Fisher." They were all equally his friends. And as the last words of the memorial service were read, each person there, no doubt, carried in his mind the picture of the man who loved life, who gave without reserve of himself, and who was to all of them a gay and stimulating companion.

MORE ON THE ECLIPSE COMET OF 1948

(Continued from page 110)

much better, but the tail is too much underexposed to show except with a magnifying glass. Viewed in this way, and accepting the idea that the root of the tail will point away from the Sun, one can see enough indications of curvature to make it seem that it is convex to the west; I therefore included in my cable a guess that the motion would be westwards, and this has proved correct. The comet must certainly have been very bright; these pictures were taken with an aperture of f/5.6 and an exposure of 1/300 second; moreover, the head was visible for some 5-10 seconds after the end of totality. It must certainly have been brighter than Venus. I have now measured up three separate negatives, and they agree closely in giving a distance from the centre of the Sun of 105.4 minutes, and a position angle of 230°; however, there is some possibility of systematic error, and I have written to the Air Commodore to ask for further details. If systematic errors can be eliminated, the place should, I think, be useful for orbit determinations; it is a week earlier than any other place."

REVISION OF THE BD

The *Bonner Durchmusterung,* consisting of charts and catalogues giving the positions of stars north of −23° for stars as faint as 9th magnitude or fainter, is one of the most useful astronomical publications. Published in 1886 for stars between −2° and −23°, and last reprinted in 1903 for the northern stars, the current availability of the *Durchmusterung* is limited. Hence it is welcome news that, at the request of the International Astronomical Union, the observatory at Bonn, Germany, is making preparations for a new edition.

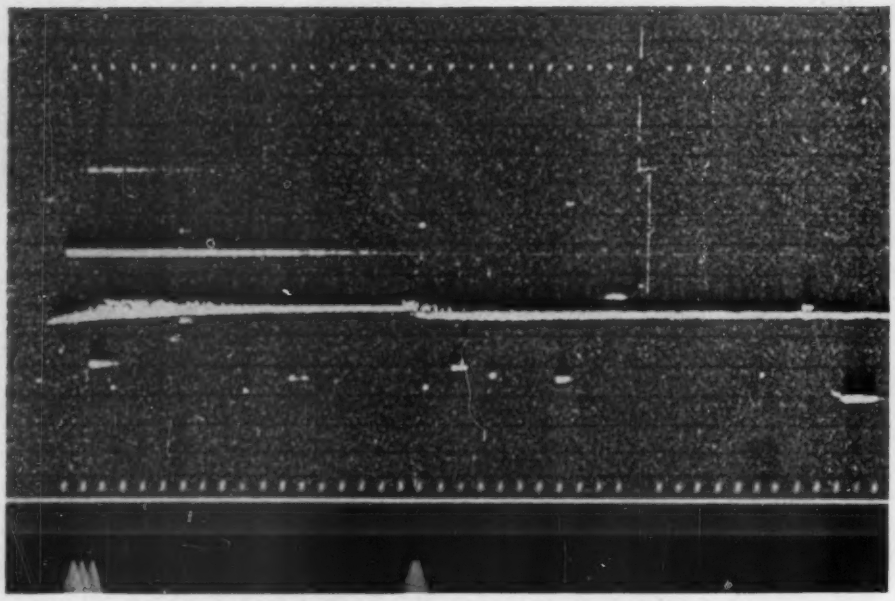
In Focus

NORTH of the Great Nebula in Orion lies the nebulosity pictured on this month's back cover, NGC 1977, described in Lick **Publication** Vol. XIII, as "a wonderful mass of bright diffuse nebulosity covering an area nearly 30′ by 20′." The back-cover photograph was made on January 7, 1921, with the Hooker 100-inch reflector at Mount Wilson Observatory, exposure five hours, 40 minutes, aperture 84 inches. The orientation here is with west at the top. Dr. John C. Duncan, of Wellesley College, in an article discussing this picture, has said:

"This magnificent mass of light surrounds the 5th-magnitude star c Orionis, the northernmost star of the Sword of Orion, and is connected with the Great Nebula around Theta Orionis by faint nebulosity . . . . The dark indentation in the south side [at the right] is by no means wholly without luminosity, although it seems so on the halftone reproduction. The luminous streaks that appear within it on the original negative, and its bright border on the north are suggestive of the dark 'bay,' Barnard 33, south of Zeta Orionis.

"The bright ring around the star west of the nebula is of course due to halation, the backing of the plate having been lacking at that point." The secondary mirror supports cause the four-pointed diffraction patterns of this and other stars' images.

In the Orion field picture on page 45 of the December issue, this back-cover area is only about half an inch long; the star at the top of the back cover is nearly two inches from the left edge and more than 1¾ inches from the top of the field picture. There the nebulosity is relatively overexposed, so it seems to have greater extent, but much less detail, than it does in this month's large-scale back-cover reproduction.



A typical radar meteor record. The first horizontal range line above the seconds markers is for 40 kilometers, the next is at 60 kilometers, and so forth. At the left, starting at a range of about 150 kilometers is a Delta Aquarid, its echo ending near the start of a Perseid meteor of about the same height. Above the Delta Aquarid, at a slant range of nearly 200 kilometers (but vertically only about half that high), is the echo of another Perseid that appeared only a second after the Delta Aquarid. The "shadow" effect above the echo markings is introduced electronically into the record. The meteor paths producing these echoes were all between heights of 80 and 100 kilometers above sea level. Photograph by the National Research Council of Canada.

Three-Station Radar and Visual Triangulation of Meteors*

By Peter M. Millman, *Dominion Observatory,*
and D. W. R. McKinley, *National Research Council*

EARLY in the summer of 1947 the Dominion Observatory and the National Research Council, both of Ottawa, commenced a co-operative program of meteor observation. The observatory organized the visual and photographic portions of the program while the National Research Council designed and operated all the radar equipment. The basic purpose of this investigation is a detailed correlation of visual, photographic, and radar data. For this reason most of the observing program has been carried out during well-known meteor showers when large numbers of meteors with known radiants were available for study.

The radar equipment has been operated in the band 30-36 megacycles per second (10.0-8.3 meters wave length). The Ottawa transmitter has operated with peak power as high as 400 kilowatts. The other stations use portable equipment with smaller peak power. The pulse widths vary from four to 20 microseconds and the receivers in use have a sensitivity of the order of 10^{-14} watts. Single half-wave dipoles are employed on both the transmitters and receivers. The radar echoes are recorded on a continuously moving film where range (or distance from the observer) appears as ordinate against time as abscissa. Ordinates are marked off in 20-kilometer divisions and seconds pulses from Station CHU, Ottawa, appear at the top and bottom of the record. All visual observers are provided with push buttons operating an illuminated indicator that records on the film the times of the visual observations.

Since the summer of 1947 the following observational data have been collected:

100	meteor photographs, both direct and spectrographic
5,000	visual meteor plots and magnitude estimates
50,000	photographic recordings of Doppler meteor whistles
1,500,000	photographic records of meteor radar echoes

In previously reported results (see *Sky and Telescope,* VII, 123, March, 1948) we have indicated the dependence of the form of the echo on the distance of the meteor from the radiant (that is, on the angle between the meteor path and the line of sight). We have also shown, in agreement with others, that the great majority of meteor echoes are produced in a fairly restricted region of the upper atmosphere centered somewhere between 90 and 100 kilometers above sea level. Since the radar employed was essentially non-directional, all height data depended on a correlation of visual and radar observations.

The picture shown above is a typical example of a radar meteor record taken at the Ottawa station on the morning of July 29, 1948. In the record of seconds pulses at the top and bottom

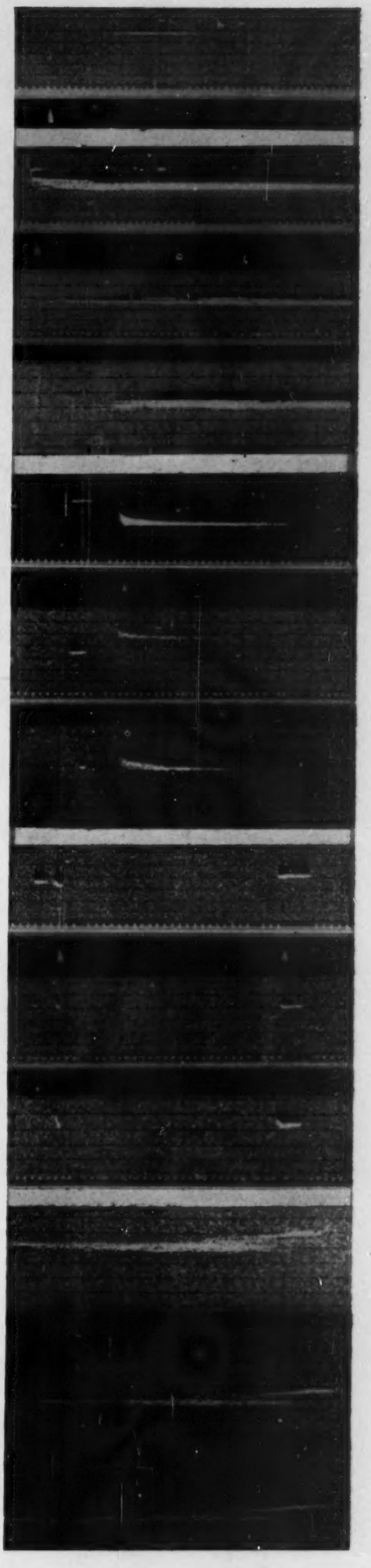
The method of making visual meteor observations at the radio field station of the National Research Council of Canada. The location is on the Metcalfe Road, about six miles south of Ottawa. Dominion Observatory photograph.

*A paper presented at the 80th meeting of the American Astronomical Society, New Haven, December 28-31, 1948.

of the picture, the first second after the break at the left is $3^h\ 14^m\ 00^s$. Range marks, 20 kilometers apart, are the relatively dark horizontal lines. Upwards of 20 meteor echoes appear on this portion of the film. The three strongest correspond to three visual meteors: a Delta Aquarid of 1st magnitude at $3^h\ 13^m\ 59^s$; a Perseid of 2nd magnitude at $3^h\ 14^m\ 00^s$; and a Perseid of 3rd magnitude at $3^h\ 14^m\ 18^s$. The Aquarid was about 100 degrees from the radiant, and the two Perseids between 40 and 50 degrees from the radiant. At least five visual observations of these three meteors are indicated by the diamond-shaped markers at the bottom of the film.

To investigate the possibility of height determination by radar alone, three stations located at Ottawa, Arnprior, and Carleton Place, respectively, were put into operation in August, 1948. The base lines between stations were 36, 41, and 57 kilometers in length. Photographic, visual, and radar observations were carried out at all three stations. It was found that a large percentage of the meteors producing enduring echoes were detected by all radar sets. Where visual observations were also available from two or more points this made possible the computation of heights in three ways: by the use of the three radar ranges, by the combination of one radar range with a visual plot, by the use of two or more visual plots.

To study the relation among heights determined by the three methods, detailed computations have been carried out for the night of August 10-11, 1948. Since the computation of meteor heights by radar range alone becomes insensitive for objects at long ranges, the most reliable results are obtained from meteors with subpoints less than 150 kilometers distant from the centroid of the three observing stations. A total of 41 meteors was found which satisfied the above condition, had radar echoes from all stations lasting over one second, and were visually observed from at least one point. As shown in the diagram on page 116, left-hand section, the values of the mean radar height for each meteor varied from 79 to 112 kilometers, with an average height of 94 kilometers. The corresponding values for the same 41 meteors found by combining radar ranges with visual plots gave heights from 68 to 142 kilometers, average height 100 kilometers, as shown in the second section of the diagram. The ad-



Three-station radar records of six Perseid meteors, in order of increasing distance from the radiant. Each group of three frames shows the same meteor from (top to bottom) Ottawa, Arnprior, and Carleton Place. The latter stations are, respectively, west and southwest of Ottawa. For meteor No. 1, top of panel, only the Ottawa record is included.

CLASSIFICATION OF METEOR RADAR ECHOES

From the **Journal** of the Royal Astronomical Society of Canada, May-June, 1948, is taken the following classification of complex meteor radar echoes adopted by Drs. Millman and McKinley. The range-time plot of a meteor moving past an observer along a straight line at a constant velocity is in the form of a hyperbola. The two arms of the curve correspond to the approach and recession of the meteor, respectively, and the form of the hyperbola will depend upon the meteor's velocity and the length of the perpendicular from the observer to the meteor's path. The basic types of meteor echo are:

A. Indication of decreasing range or approach (distance from radiant less than 90°).

D. Indication of increasing range or recession (distance from radiant more than 90°).

U. Both approach and recession (both arms of hyperbola present).

E. Two or more discrete ranges, no motion evident.

F. One discrete range, no motion evident.

Secondary characteristics include the following:

h. Instantaneous head echo moving with the velocity of the meteor.

b. Moving echo with measurable and continuously variable duration.

e. Two or more echoes at discrete ranges.

f. One echo at a discrete range.

s. Duration under one second.

2, 3, 4, etc. Number of components.

Dr. Millman's classification of the echoes of the six meteors shown in the adjoining panel, for the Ottawa station (top frame of each section), is as follows: 1. **F.** 2. **Ahe4**; the **h** characteristic or head echo is the sharp slanting line at the beginning of the enduring portions of this multiple echo. 3. **Abf**; the **b** characteristic is the heavy curving portion at the beginning of the enduring trail. 4. **U** and **F** (two meteors). 5. **De5**; a meteor more than 90° from the radiant, therefore receding from the observer.

From top to bottom of this panel, the meteors occurred at the times below and have the following respective absolute magnitudes, distances from the radiant, and heights of radar echoes:

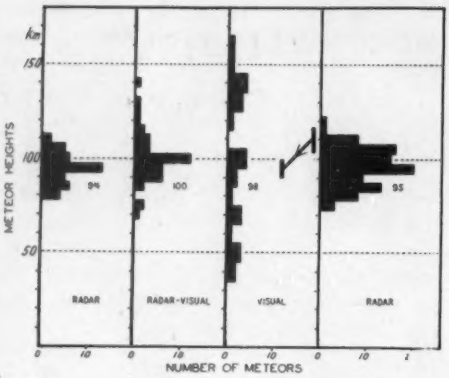
1.	0:07:47 EST	−½ mag.	10°	103 km.
2.	1:19:28	0	50	100, 97, 94
3.	23:22:21	0	70	118 to 96
4.	22:06:25	2	90	113 to 97
	22:06:55	1	90	94
5.	22:42:27	−3½	120	127, 122, 101, 98, 86

The absolute magnitude is defined as that brightness the meteor would appear to have if seen in the zenith at a height of 100 kilometers.

dition of 21 meteors of long range or with very short duration echoes did not materially alter these figures.

Heights computed purely from visual plots showed a much greater spread and were not accurate enough to be of value individually, but as the third section of the diagram shows, the mean height of 26 meteors computed from visual observations alone was 98 kilometers, agreeing well with the other results.

It would appear that, for the August period, the heights computed from radar alone average somewhat lower than those found from a combination of visual and radar data. This indicates that there is a tendency for the radar echo to occur near the end of the visual trail — for the Perseids at least. Confirmation of this fact, and a check on the reliability of the correlation of the radar echoes with visual meteors, was found by computing from the radar ranges alone the position of each echoing source in the sky and then comparing this with the visual meteor plot. The mean angular distance on the celestial sphere of all radar points from the corresponding visual meteor plots was only seven degrees, a good agreement since this figure includes the summed effect



Frequency plots of the heights of meteors found in the three ways described in this article. Note the spread of the visual results compared with the relatively narrow limits of the radar observations. Details of this chart are given in the text.

of at least five separate sources of error. Over twice as many radar points were plotted near the ends of the visual trails as near the beginnings.

Additional radar heights were computed for meteors appearing on the same night, but not visually observed. A compilation of all radar heights determined, corresponding to a total of 94 different meteors (fourth section of the diagram) gave a mean height of 95 kilometers. The moving type of echo (*b* or *h* classification) was observed for 16 of these meteors. The small line in the third section of the diagram (with the arrow) indicates the mean height of the appearance of this echo at 110 kilometers and that of disappearance at 95 kilometers. The vertical lines indicate the mean deviation of the beginning and ending values.

It seems clear from the above results that meteors produce ionization clouds which may be satisfactorily detected on the 30-megacycle band from widely separated points on the earth's surface. Triangulation of these clouds by range measurements alone is practical and yields results which compare favorably with those obtained by any other methods. This technique, when applied to individual meteor echoes of certain types, makes possible the accurate determination of daytime meteor paths and orbits. It may also be noted that these results confirm our earlier conclusions concerning echo heights and the relation between the echo form and distance from the radiant.

TERMINOLOGY TALKS--

J. Hugh Pruett

Parabola, Hyperbola

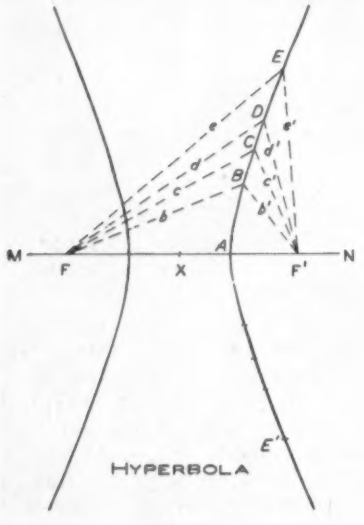
If the eccentricity reaches 1.0, the orbit is a parabola; if it exceeds this value, a hyperbola. Neither is a closed curve, and if any observed comet actually travels on such an orbit, it will never return.

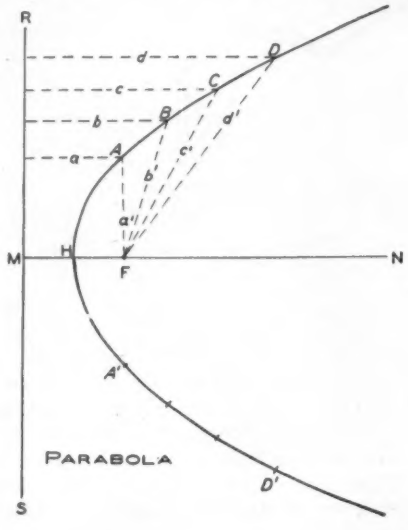
A parabola is a plane curve the points on which are always equally distant from a fixed point, called the focus, and a fixed line, called the directrix. In the figure, *F* is the focus and *RS* is the directrix. *MN* is the axis of the parabola. All points on the curve must be constructed equidistant from *F* and from the line *RS*. The distance to the line is measured at right angles to it, and the first point on the curve, *H*, is easily seen to be midway between *F* and *M*. *A* is at the distance *a* from *RS* and *a'* from *F*, but *a* and *a'* are equal. The same principle applies to points *B*, *C*, *D*, and so on. As the eccentricity is one, all parabolas have the same shape, although they are of various sizes.

The two arms of a parabola extend out to an infinite distance without meeting — they approach parallelism to the axis *MN* and to themselves. A comet starting from the region of the sun (*F*) along *H*, *A*, *B*, *C*, will never be found returning to "home base" along *D'* and *A'*. A parabolic orbit is a very special case which requires that an object be at rest with respect to the sun at infinity. Therefore, it is not expected that any celestial body passes the sun in exactly such a path, and if an orbit is not closed as an ellipse, it is probably a hyperbola.

The hyperbola is a plane curve at any part of which the difference of the distances to two fixed points, the foci, is constant. There are two oppositely extending curves to a complete hyperbola, but we are usually concerned with only one of them. As the eccentricity of a hyperbola is greater than one, hyperbolas may be of any shape, whether they be large or small.

In the figure, *X* is the center of the hyperbola, and *F* and *F'* are the two foci. $FA - F'A =$ a constant, and this common difference applies to the distances *b* and *b'*, *c* and *c'*, *d* and *d'*, and so on. The curves at *E* and *E'* continued toward the right will never meet nor approach parallelism, but they will approach a fixed angle to each other. A comet on such an orbit, after rounding the sun at *F'*, would go off into the immense cosmic spaces never to return.





PHOTOGRAPHIC PLATES

A new booklet describing special plates available for spectroscopy, astronomy, and nuclear research, entitled *Photographic Plates for Scientific and Technical Use,* has been published by the Eastman Kodak Company. It contains information on the spectral sensitivity of a wide range of photographic emulsions and suggestions on the selection of plates for observations in various regions of the spectrum. The booklet is available on request from Eastman Kodak Company, Rochester 4, N. Y.

Amateur Astronomers

Astronomical League Convention at Cleveland

ON THE WEEKEND of July 2-4, 1949, members and friends of the Astronomical League, and all interested amateur and professional astronomers, will gather in Cleveland, Ohio, for the league's annual convention, at the invitation of the Cleveland Astronomical Society and Dr. J. J. Nassau, director of the Warner and Swasey Observatory. Meeting sessions will be held in the physics lecture room of the Case Institute of Technology. The convention program plans will be under the direction of a committee of the Middle East region of the league, of which Charles H. LeRoy is regional chairman.

The 1949 gathering will be the third national convention of the Astronomical League, but will mark the 10th anniversary of the first convention of amateur astronomers whose delegates were concerned with the problem of permanent organization among groups of amateurs. In New York City, during the World's Fair of 1939, the problem was first considered, as reported in The SKY, October, 1939:

"At the general session on August 20th a committee on permanent organization was elected, to draw up plans for a more definite nation-wide organization of amateur astronomical societies. A federation of societies was proposed, as well as a council of regional representatives to coordinate the work of various groups."

The committee on permanent organization worked throughout the following year, reported at the second national convention in Pittsburgh in July, 1940, and continued with the problem, until in 1941, at the convention in Washington, D. C., there was offered "a proposed constitution for an organization of societies, to be called the Amateur Astronomers League of America." A resolution was adopted that the AALA should start functioning when 10 societies had ratified the proposed constitution. Although 11 groups had ratified or tentatively accepted the by-laws by early 1942, the invitation to meet in Detroit that had been extended at the Washington convention was regretfully withdrawn in the spring of that year, and organization of the league had to be suspended until more propitious times.

The two Detroit astronomical societies renewed their invitation in 1946, and high on the agenda of the Cranbrook convention was the problem of national organization. By-laws of the then named Amateur Astronomers League, based on the older ones and incorporating recent suggestions, were worked over by this organizational convention. Ratification by 10 societies was accomplished by November 15, 1946, with the number of member groups up to 22 by the end of December. Thus, with temporary officers and national council, the first convention of the AAL was held in Philadelphia on July 4th weekend of 1947. The following year saw the organization of several regions within the league, and adoption of a final change of name to the present Astronomical League. By the time of last year's convention in Milwaukee, the league had 46 members, including two foreign groups, and four organized regions.

At Cleveland many problems of general interest will occupy the delegates. These include the organization of regions of the league as yet unformed, comprising the entire southern half of the United States, the establishment of activity sections and their programs, and the planning of efforts to encourage non-member groups to join the league.

Amateurs who plan to present papers at the Cleveland convention should have their titles and brief abstracts of at least 50 words in the hands of the executive secretary, James B. Rothschild, 209 W. 21 St., New York 11, N. Y., six weeks in advance, or by May 21st, in order to be included in the program. Complete papers or more extensive abstracts may be submitted at any time before the close of the convention, and this material will be included in the proceedings to the extent that space permits. The time allotted for oral presentation of each paper shall not normally exceed 10 minutes.

H.S.F.

North Central Region

THE NORTH CENTRAL region of the Astronomical League was organized at a meeting in Duluth, Minn., August 30, 1947, with the Darling Astronomy Club as host society.

Since the 1948 general convention of the league was held in the region, there was no regional convention last year, other than the business meeting held after the close of the league convention in Milwaukee. Officers then were re-elected as follows: chairman, Dr. C. M. Huffer, Madison, Wis.; vice-chairman, Neil Lockwood, Duluth, Minn.; secretary-treasurer, Miss Elizabeth Wight, Milwaukee, Wis. The chairman was appointed representative of the region on the national council. The Madison Astronomical Society invited the region to hold its 1949 annual meeting in Madison, the date to be selected by the host society.

North Central convention plans: When it became probable that Sir Harold Spencer Jones, Astronomer Royal of England, would speak at the University of Wisconsin on April 1, 1949, April 2nd was set as the date of the 1949 convention. Invitations are being sent to the member organizations to attend Sir Harold's lecture entitled "Is There Life on Other Worlds?"

On the morning of April 2nd, the Washburn Observatory will be host to the region — the photoelectric apparatus will be demonstrated and a lecture given by Dr. A. E. Whitford, director of the observatory, on the use of the photocell in astronomy. There will also be a discussion of society meeting plans and programs, with the hope that all the groups of the region will take part.

In the afternoon, there will be reports of observational activities from the various member organizations, followed by the annual election of officers and the selection of the next convention place. To date, there have been no reports of observations made to the region or to its council. It is hoped that this forthcoming convention will serve as a stimulus and that in spite of the unfavorable weather conditions in the region, particularly in the winter, an active program of observing can soon be mapped out for the coming months.

In the evening, the convention will close with a banquet, at which time the film, The Story of Palomar, will be shown.

C. M. Huffer
Chairman, North Central Region
Washburn Observatory
Madison, Wis.

Northeast Region

THE MEMBERSHIP of the Astronomical League may be divided into three groups. The largest is made up of those who attend meetings and classes of their local organizations and generally enjoy the cultural value of astronomy. The second group spends some time with the hobby of making telescopes and they use their instruments in casual observations. Relatively few amateurs can be included in the third group. Their interest is possibly keenest of all, for they spend much time constantly improving their instruments, adding to their accessories, and working on programs of observing which they hope will be of value to the professional astronomer. It is reasonable to expect that the enthusiasm of these few will make converts to well-planned observing and instrumental programs.

The conventions sponsored by the region are at present its outstanding activity and are of great value in making possible progress along other lines. Contacts are formed with distant members and often maintained by correspondence. The Northeast region is looking forward eagerly to its second convention, to be held in New York in April, and this gathering should be a

worthy successor to the convention at New Haven last year. More time will be given to the sectional meetings on observing and instruments, to the advantage of these activities.

Perhaps it is regrettable that more tangible progress cannot be reported at this time. The region's second birthday is some time off, however, and it seems certain that steady growth lies ahead. Further stimulus will be provided by the instigation of national observing programs by the Technical Advisory Council and by the establishment of activity sections, both of which are now under way.

Convention plans: With the Bergen County Astronomical Society and the Junior Astronomy Club as hosts, the Northeast regional convention will be held on Saturday and Sunday, April 23rd and 24th, at the American Museum of Natural History in New York City. There will be an address of welcome by Gordon A. Atwater, curator of the Hayden Planetarium, section meetings and discussions, and on Saturday night concurrent field trips. The principal speaker of the convention will be Dr. Bart J. Bok, Harvard College Observatory, on "The Center of the Galaxy."

Each society in the region is being asked to appoint two delegates to represent it and to attend the program section meeting. These delegates are to be prepared to discuss the formation of a list of speakers (amateur and professional) compiled from past records of the meetings of societies in the region.

The field trips will be to the Rutherfurd Observatory of Columbia University, the Bergen County Astronomical Society Observatory, the Fordham University seismograph station, and the Watson Computing Laboratory of IBM. As the number of persons that can be accommodated on each trip is limited, places will be allotted to advance registrants in order of the receipt of applications. Registration blanks may be obtained from the convention treasurer, Mrs. Arthur I. Lee, 244 West 74th St., New York 23, N. Y.

Mrs. Lee is also making arrangements for hotel accommodations at the Manhattan Towers, Broadway at 76th Street, but after March 1st the availability of rooms there cannot be guaranteed. Room prices range upward from single, without bath, $3.00; with bath, $4.00; to two connecting rooms, with bath, for two or three persons, $8.00.

Further program details for this convention will be announced next month. As with all Astronomical League conventions, all interested persons are invited to register and attend the sessions, but voting is restricted to league members.

CHESTER S. COOK
Chairman, Northeast Region
16 Belfry Terrace
Lexington 73, Mass.

THIS MONTH'S MEETINGS

Chicago, Ill.: The meeting of the Burnham Astronomical Society at the Chicago Academy of Sciences will be on Tuesday, March 8th, at 8:00 p.m. Impromptu reports on the March evening sky will be followed by a discussion on telescope making and observing. Then The Story of Palomar, Caltech color and sound motion picture, will be shown.

Cleveland, Ohio: Dr. Otto Struve, of Yerkes Observatory, will speak at the regular meeting of the Cleveland Astronomical Society on March 18th, 8:00 p.m., at the Warner and Swasey Observatory, on the subject, "Evolution of Stars."

Public nights will be held at Warner and Swasey Observatory on the evenings of March 10th and 11th. The lecture is at 8:00 p.m., "Exploring the Universe." Reservations can be made through the Case Institute of Technology.

Detroit, Mich.: The Detroit Astronomical Society will have as its speaker on Sunday, March 13th, Dr. Otto O. Fisher, who will show volcano movies, including eruptions of Mauna Loa. The meeting is at Wayne University's new state hall at 3:00 p.m.

Geneva, Ill.: The March meeting of the Fox Valley Astronomical Society is on Tuesday, March 1st, in the City Hall, at 8 o'clock. The second of two lectures on geology will be given: "Earth's Climatic Changes from the Silurian to the Present Geologic Period," by the Reverend Frank Hancock.

Indianapolis, Ind.: At the meeting of the Indiana Astronomical Society on March 6th, Cropsey Hall at 2:15 p.m., Dr. Frank K. Edmondson, of Indiana University, will speak on "What We Want to Know."

Los Angeles, Calif.: The regular meeting of the Los Angeles Astronomical Society for March 8th has been canceled to permit facilities of the Griffith Observatory to be made available to the Astronomical Society of the Pacific. On that date the ASP is sponsoring a lecture by Sir Harold Spencer Jones, Astronomer Royal of England, on "The Origin of the Solar System." Admission is by card only through application to the Griffith Observatory.

Madison, Wis.: "The Physical Nature of the Sun" will be discussed by Dr. J. H. Gieselman at the March 9th meeting of the Madison Astronomical Society, 8 o'clock in Washburn Observatory.

Minneapolis, Minn.: At the annual meeting of the Minneapolis Astronomy Club on March 2nd, Francis S. Appel will speak on "The Nearest Star and Some Close Relatives." At the March 16th meeting, "The Galactic System" will be discussed by Kent H. Brazwell. Both meetings are at the Minneapolis Public Library at 7:30 o'clock.

New York, N. Y.: Dr. John E. Merrill, of Hunter College, will speak on "Eclipsing Variable Star Research" at the March 2nd meeting of the Amateur Astronomers Association, 8:00 p.m. in the American Museum of Natural History.

The annual meeting and elections of the Junior Astronomy Club are to be held on March 25th, in the American Museum of Natural History at 7:30 p.m. The Story of Palomar will also be shown.

Philadelphia, Pa.: Dr. George Van Biesbroeck, of Yerkes Observatory, will give a lecture on Wednesday, March 2nd, at a joint meeting of the Rittenhouse Astronomical Society and the Franklin Institute. His subject is "Comets," and the lecture is at 8:15 p.m. at the Franklin Institute.

Pittsburgh, Pa.: Dr. W. N. St. Peter, of the University of Pittsburgh, will give a demonstration lecture entitled "A Journey Through the Realm of Vision," at the Friday, March 11th, meeting of the Amateur Astronomers Association. The lecture will be in Room G-6 of the Cathedral of Learning, at 8:30 p.m.

Rochester, N. Y.: Dr. George Gamow, of George Washington University, will speak on "Optics Three Billion Years Ago," at the March 4th meeting of the Optical Society of America, Rochester section, and the Astronomy Group of the Rochester Academy of Science, at the Bausch Museum, 8:00 p.m.

Stamford, Conn.: "The Minor Planets or Asteroids" will be the subject of the talk by Dr. Charles P. Olivier, of Flower and Cook observatories, at the March 18th meeting of the Stamford Amateur Astronomers, 8 o'clock in the Stamford Museum.

Washington, D. C.: Dr. Helen W. Dodson, of the University of Michigan and Goucher College, will lecture at the meeting of the National Capital Astronomers on Saturday, March 5th, 8:15 p.m. in the Commerce Department auditorium. Her subject is "New Aspects of Solar Activity."

LEAGUE PUBLICATIONS

The **Proceedings** of the second general convention of the Astronomical League, held at Milwaukee, July 3-5, 1948, have been published by the executive secretary. The contents include abridged minutes of the general sessions, and abridged minutes of the council meetings. Next, there is a report of the observations section meeting, abstracts of three papers on observing, two on telescope making, and one on variable stars. The report of the committee on junior activities analyzes replies to a questionnaire on the subject that was sent to member societies. The final portion of the 32-page mimeographed **Proceedings** contains fairly detailed annual reports from 21 member societies.

Junior Regional Newsletter is the title of the publication of the junior activities committee of the Middle East region, its first issue dated December, 1948, to be published quarterly. The members of the committee are John Bicking, Amateur Astronomers of the Franklin Institute; John Dobbins, Indiana Astronomical Society; John Edmonds, National Capital Astronomers; Val Eichenlaub, Battle Creek Amateur Astronomy Club; Lucian Rarogiewicz, Detroit Astronomical Society; and Gordon Urban, Amateur Astronomers Association of Pittsburgh. Eight articles on varied topics are included in the seven pages of the newsletter, which is edited by the chairman of the committee, Grace C. Scholz, National Capital Astronomers, who is also chairman of the national committee on junior activities.

He Broke Through the Barriers of the Skies

By N. A. Mackenzie

Sir William Herschel, at the age of 46, a few years after his discovery of the planet Uranus. A crayon copy of a painting by L. T. Abbott, reproduced from C. A. Lubbock's "The Herschel Chronicle," Cambridge University Press, 1933.

ONE of the greatest explorers of the heavens was by profession not an astronomer, but a musician. He was Friedrich Wilhelm Herschel, a German, who more than a century and a half ago played a church organ at Bath by day and, after augmenting his meager salary by giving music lessons at night, devoted the remaining small hours of the morning to the study of the stars.

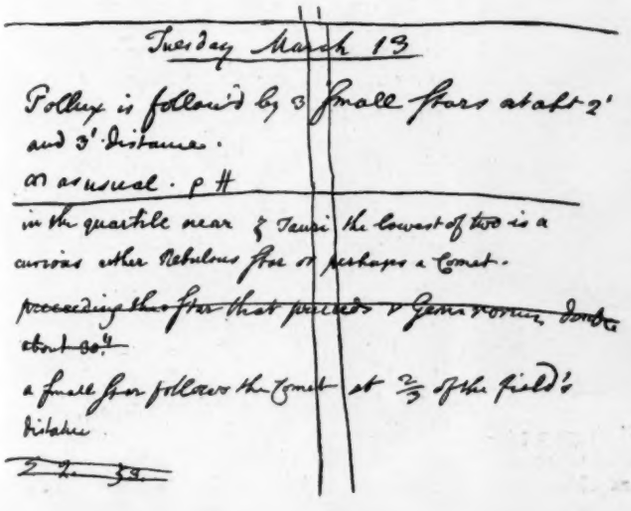
At first, being too poor to buy a telescope, he had to be content with reading books on astronomy. Then one of these particularly captured his interest, making him so enthusiastic that, to quote his own words, "I resolved to take nothing on trust, but to see with my own eyes all that other men had seen before me."

In May, 1773, he managed to rig up a telescope with a cardboard tube and some lenses. With this simple instrument he observed the planet Jupiter and its satellites. But when he began devising more powerful telescopes the tube grew so long and awkward that he turned his attention to the shorter reflecting type of telescope. The large mirror he wanted, however, proved too costly for his slender purse. Nothing daunted, he decided to make one for himself. The necessary apparatus he was lucky to obtain from a friend who was giving up his hobby of grinding mirrors.

Herschel's first mirror was only five inches in diameter, and at least once he kept continuously grinding, keeping his hands on the work, for 16 hours at a stretch, while his sister Caroline supplied him with food and read stories aloud to pass the time. At last, on March 1, 1774, after some 200 mirrors had been failures, Herschel was able to point his finished telescope to the stars and begin observing. On that evening he proudly made the first entry in his astronomical diary, stating that he had studied "the lucid spot in Orion's sword belt, and the ring of Saturn, which appeared like two slender arms." Helped by Caroline, who chronicled his observations, he devoted the next eight years to studying planets and making an exhaustive review of the heavens.

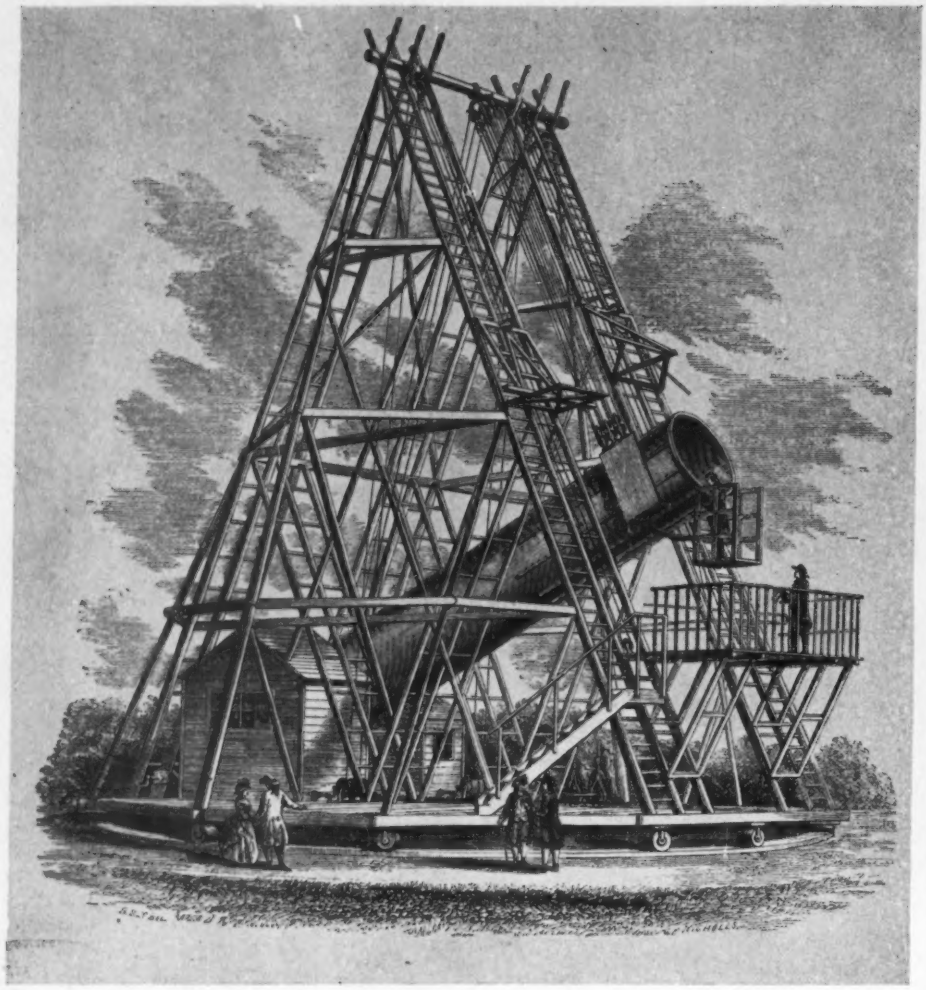
His work on the planet Mars was epoch-making, for he was the first to make a systematic study of the white spots at the north and south poles of the planet, and to infer from their seasonal changes in size that the caps were areas of snow and ice deposited from an atmosphere. "The analogy between Mars and the earth," Herschel wrote in 1783, "is perhaps by far the greatest in the whole solar system." How significant these words became nearly a century later when, in 1877, the Italian astronomer Schiaparelli discovered the canal-like markings on Mars which set the whole world talking about possible life on the planet.

Herschel's survey of the heavens, commenced in 1776, with a 6¼-inch mirror of seven feet focal length, was the most ambitious project ever attempted by any astronomer. It amounted to nothing less than counting the whole of the stars in the heavens! To


Tuesday March 13
Follows is followed by 3 small stars at abt 2'
and 3' distance.
as usual. p #
in the quartile near ζ Tauri the lowest of two is a
curious other Nebulous star or perhaps a Comet.
a small star follows the Comet at ⅔ of the field's
distance

(Left) A portion of the page in Herschel's journal in which he recorded his discovery of Uranus, March 13, 1781. The writing is reduced to about half its original scale. Uranus' sidereal period is 84.01529 years; thus, this month the planet completes two revolutions since 1781.

(Right) A Yerkes Observatory photograph of Titania and Oberon, the 14th-magnitude satellites of Uranus discovered by Herschel. The image of the planet is heavily overexposed.



The mightiest telescope of its day, Herschel's 48-inch reflector at Slough.

have counted the stars separately would, of course, have been impossible, so the work was done by means of sample counts taken in different small areas of the sky, just as astronomers do today. In this way, Herschel deduced the distribution and total number of all the stars in the firmament to the limiting magnitude of his survey. His purpose was no less ambitious than to ascertain the structure of the whole starry universe.

On March 13, 1781, while on this task, he detected a hazy object that appeared different from a star. Viewed with higher powered lenses the object enlarged to a sensible disk, while the distant stars did not. A few hours later he saw that the stranger had moved, making him think he had discovered a comet. Believing it to be such, mathematicians tried to calculate the body's future path in the sky. These efforts failed, however, and nearly a year later the astronomer Lexell finally announced that the mysterious object was not a comet at all, but a planet.

Later it transpired that the planet had been observed several times during the century preceding its discovery, but had always been mistaken for a star. Among the experienced observers who had thus missed fame by a hairsbreadth were — of all people — two astronomers royal. And another astronomer (Lemonnier) had actually seen the planet 12 times, once noting its position on an old paper bag.

Caroline Lucretia Herschel, from a portrait by Tielemann in 1829, when she was nearly 70 years old.

The achievement rocketed Herschel from obscurity to fame, for the planet was the first ever to be discovered apart from the sun's nearer planets, which had always been visible to the naked eye. He was honored by the leading scientists of the day and by King George III, who appointed him as his private astronomer at a salary of £200 a year.

To show his gratitude Herschel named the new planet "Georgium Sidus," but Continental astronomers objected to this departure from the custom of naming planets after ancient gods. The father of Mars, according to ancient mythology, was Jupiter, his grandfather Saturn, and his great-grandfather Uranus; so that eventually Herschel's planet, which lay next beyond Saturn, was called Uranus, at Bode's suggestion.

After some difficulty in finding suitable accommodation for his expanding activities, Herschel got settled at Slough in 1786. Here for about 35 years he crammed the days with making, repairing, and adjusting telescopes and preparing his observations for submission to scientific societies.The nights — from dusk to dawn, with the faithful Caroline ever at his side, even though the ink froze in her pen or mirrors cracked — were spent sweeping the heavens for stars and universes, counting the stars in limited parts of the sky, and studying the moon and the planets. About the only time they got any sleep was when the moon or clouds made observation impossible.

Nor was Caroline long in winning separate laurels. On August 1, 1786, while Herschel was away on a visit to Germany, she made the first of eight comet discoveries, which gained her immediate recognition and a small annuity.

In the following January, Herschel made a novel experiment with his 20-foot Newtonian telescope. He dispensed with the secondary mirror, which was reducing the light gathered by his instrument, and thus was able to discover two faint satellites of Uranus. Reflectors of this new design became known as Herschelian.

Fortune, as well as fame, now came to Herschel, for in May, 1788, he married Mrs. Mary Pitt, a wealthy widow. A famous novelist who visited them soon after the marriage wrote of her, "His wife seems good-natured: she was rich, too!" Then he hinted, for what it was worth, "And astronomers are as able as other men to discern that gold can glitter as well as stars."

The peak of Herschel's career as a telescope maker was reached in August, 1789, when after nearly four years of prodigious labor and at a cost, financed by the government, of £4,000, he completed his 40-foot telescope, 48 inches in diameter. This huge instrument was the wonder of the age and royal personages and scientists visited Slough

The Rev. Sir John Charles William Herschel, last of the Herschels, and great-grandson of Sir William Herschel. Photograph by Margaret Harwood, at Slough, October 17, 1948.

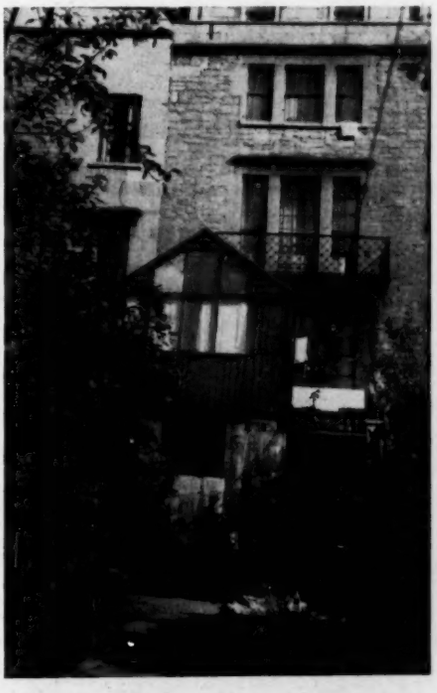
from all over the world to view it.

By its means, almost on its maiden voyage of the heavens, Herschel discovered a sixth satellite of Saturn, and, three weeks later, a seventh. In addition, he detected a spot on the surface of Saturn, and in 1793 made the first determination of the planet's rotation, as 10 hours, 16 minutes. He also carried out important observations of the rings that surround the planet.

In 1803, Herschel solved a major problem of astronomy by explaining the peculiar occurrence of double stars. Astronomers saw so many of these close pairs while cataloguing their numbers that they believed many must be real doubles — not merely the optical effect of stars distantly separated but almost in line with each other as seen from the earth. It was not until 1803, however, that Herschel announced that he had detected the orbital motion, or revolution of one star around the other, in a number of pairs. Among these were such well-known doubles as Epsilon Bootis and Gamma Virginis. This discovery was made possible by the time elapsed since he had begun to scan the heavens a quarter of a century earlier. It provided the first direct evidence that the law of gravitation, which accounts for the motion of the planets revolving around the sun, operated among the distant stars.

As early as 1783, with the proper motions of only 13 stars known to him, Herschel had established the direction in space toward which the sun is carrying the earth and the other planets in the solar system. Near the star Lambda Herculis he placed the apex of the sun's way, for at right angles to this direction he found the stars seemed to be moving past us toward the opposite point in the sky. His position for the apex agrees remarkably well with that which is accepted by astronomers today.

Herschel's crowning achievement was the picture he built up from his surveys of the sky for the avowed purpose of obtaining "a knowledge of the construction of the heavens." In the thickly populated band of stars in the Milky Way, completely surrounding the heavens like a silvery ring, he saw the optical effect that would be produced if our star system were shaped like a lens. The scale of this majestic picture he enlarged still greater by supposing the hazy bodies called nebulae to be other star systems like that of our own galaxy. He was mistaken only in believing that *all* of these bodies (of which he discovered no fewer than 1,500) were, as he called them, "island universes." It is now known that nebulous objects comprise globular clusters, diffuse and planetary nebulae, and galaxies. In considering Herschel's theories, it is important to recall that the actual distances to the stars had not been measured in his day. In fact, it was in an attempt to measure stellar parallaxes that many of his observations were made.



The garden and rear of "Uranus," the house at 19 New King St., Bath, England, where Herschel discovered Uranus. Photograph by Margaret Harwood, September 25, 1948.

Herschel's achievements gained him the admiration and wonder of the whole world. Honors were showered on him. He was knighted in 1816, and four years later became president of the Royal Astronomical Society. But he cared little for such distinctions, and bravely carried on his studies in the face of advancing years and ill health.

On June 1, 1821, he made his last observation. He died, in his 84th year, on August 25, 1822, and was interred in the little church at Upton where he had been married. On his tombstone are inscribed the words, *Coelorum perrupit claustra* — "he broke through the barriers of the skies."

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays; 11 a.m. Saturdays, Children's Hour (adults admitted). Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. (Closed July to mid-September.) Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Tuesday and Sunday, 4 p.m. Special showings by request. Admission free. Spitz projector. Director, Ernest T. Ludhe.

AMERICAN AST

Here are highlights of some papers presented at New Haven, Conn., in December. Comp

A spectroheliogram of the sun's disk in hydrogen light, showing a bright flare that occurred on April 26, 1948. Photograph by McMath-Hulbert Observatory.

An Astrometric Binary

ALLEGHENY OBSERVATORY astronomers have found that the star GC 18985 is an astrometric binary. It is of magnitude 6.4 and is located nine degrees south of Arcturus in Bootes. Its large proper motion of 0.325 seconds of arc per year indicated that it was a relatively nearby star, and it was placed on the parallax (distance-measuring) program at Allegheny by Zaccheus Daniel in 1931. The observations were completed in 1945 and the plates have just been measured and the computations for the parallax made by Ellen Jameson.

The distance of the star came out to be 52 light-years. This was found from a series of parallax plates on which the star was photographed from opposite sides of the earth's orbit, but the shift in the star's apparent position caused by the change in our observing location was not the only shift found. Superposed on the parallax orbit was a swing east and west 2½ times as great, which indicates that GC 18985 is moving around an invisible star; the period is 12½ years.

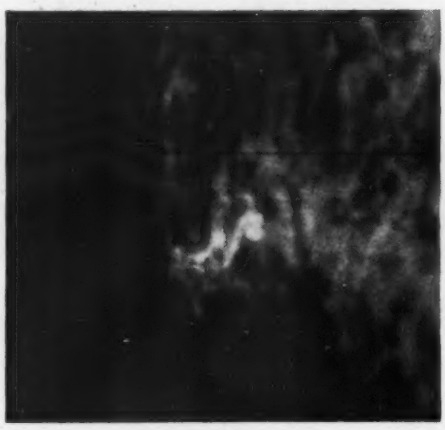
Assuming that the brighter star is a normal star of spectrum type *G*5, with a mass almost as great as the sun's, the dark companion must be nearly as massive. But if such a companion were an ordinary star it would be about as bright as the primary (visible) star, with the result that the images of the two stars would blend to form an image about halfway between the stars and no shift would have been observed. Dr. N. E. Wagman, director of Allegheny Observatory, pointed out the possibility that the dark companion might be a white dwarf star, similar to the companion of Sirius, nearly as massive as the sun but no larger than a planet, so that its light is too weak to affect measurably the observed position of the image of the normal primary star. On the other hand, the invisible companion could itself be double, two very faint red dwarf stars.

Dr. Wagman also reported that the star Altair is under scrutiny to determine whether or not it, too, has an invisible companion. The present accepted value of this star's distance is 16 light-years, but recent discrepancies in its parallax measures have been noted. The companion responsible for the observed shift in the star's position would be a dwarf red star two fifths as massive as the sun and seven magnitudes fainter than Altair.

Solar Flares

SPECTROHELIOGRAMS of the sun show its appearance in monochromatic light, such as that from atoms of hydrogen or calcium, and reveal phenomena usually not seen by direct photography. In hydrogen light, prominences projected in front of the sun's disk often have long filamentary forms, sometimes seeming like vortices in the regions of sunspots. In these regions, too, there frequently occur solar flares, seen normally only in monochromatic light. But as these flares are of very brief duration, usually on the order of minutes, most of them have been studied only visually and not photographically.

Now Dr. Helen W. Dodson and Ruth Hedeman, of the McMath-Hulbert Observatory, University of Michigan, have employed the 50-foot tower telescope at Lake Angelus to secure photographic records of flares during the entire passage of three highly active sunspot regions across the sun's disk from one limb to the other — a period of about two weeks in each case. In their analysis of maps bringing together more than 100 hours of observations on 23 days, they confirmed that some flares appear as long bright ropes or filaments, others as small bright dots. The successive flare positions seem to indicate a



(Left) A calcium spectroheliogram, showing a spot group near the sun's limb and a bright flare, August 17, 1947.

(Right) The method of superimposing plots of flare positions over sunspot charts. The scale of the chart is here about twice that of the spectroheliograms at the right, on which the plotted flare patterns may be traced. The small numbers give the serial order of occurrence of the flares in this spot region for the day; regions having simultaneous flares carry similar shading and the same serial numbers. McMath-Hulbert Observatory photographs.

ASTRONOMERS REPORT

presented at the 80th meeting of the American Astronomical Society here. Complete abstracts will appear in the Astronomical Journal.

Dr. H. R. J. Grosch, Watson Scientific Computing Laboratory, delivering the first paper before the American Astronomical Society, December 29, 1948. Photo by the editor.

certain underlying continuity — flares seem to lie along axes or chains, some of which are curved. Only flares at least twice as bright as the nearby bright areas of the sun's disk were included in the analysis.

Flares were found to occur repeatedly in the same location. And not only did they occur between spots, but often over the penumbra and even over the umbra of a spot, its dark central region. This fact was ascertained by superimposing plots of flare positions obtained from spectroheliograms over maps of the underlying sunspot regions, for often the sunspots involved were not visible on the spectroheliograms on which the flares were recorded.

The Michigan astronomers also found that many flares seem to follow channels already established by the dark filaments of prominences seen in projection, but the relationship is not clear at present. Although some filaments have been observed to disappear shortly after the outbreak of a great flare, cases have now been found in which the filaments continue to exist even though adjacent to or over a bright flare.

From the standpoint of the upper atmosphere, solar flares seem to be accompanied by strong outbursts of ultraviolet energy, resulting in disturbances in the earth's ionosphere that adversely affect long distance radio communications.

Galactic Cluster Evolution

TWO FACTORS have to be taken into consideration in studying the constancy of star clusters such as the Hyades and the Pleiades. One factor is the gain in the total energy of a cluster which results from close encounters between cluster members and field stars. As a result of this increase in energy a cluster tends to be broken up and its density steadily to decrease. The quantities involved are the mean velocity and mean mass of the field stars, the mean mass of the cluster stars, the mass of the cluster as a whole, its total energy, and time.

The other factor of importance is the loss of mass of the cluster caused by the escape of some of its fastest-moving stars. The fraction of stars escaping in a given time depends on the mass and radius of the cluster, and the loss of stars leaves the cluster with less energy so that it contracts. This contraction more than balances the loss of mass, and the density of the cluster increases.

At Harvard College Observatory, Uco van Wijk has made a comparison of the relative importance of these two factors in the evolution of galactic clusters. He finds that for two of the best-known clusters, the Pleiades and Praesepe, the effect of the escape of stars seems to be about 20 times as large as that of encounters between cluster members and field stars. Although the uncertainty of this figure is fairly high, Mr. van Wijk concludes that the density of galactic clusters such as the Pleiades and Praesepe is probably increasing.

In the above study of the escape of stars from a cluster, it is assumed that all stars in the cluster have roughly the same mass. Mr. van Wijk pointed out that the figures in the following table are not to be taken too literally; for instance, the time-scale implied by the table may well be off by a factor of three or so. The table shows the evolution of a cluster which at the present time, t = 0, has a density of five solar masses per cubic parsec and a radius of 2.5 parsecs.

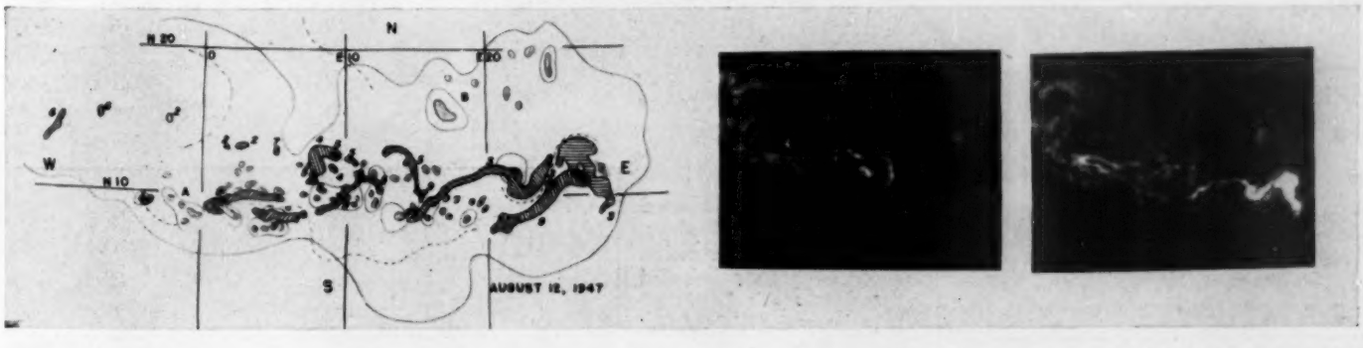
Time is given in units of 100 million years; density in solar masses per cubic parsec; radius in parsecs; and mass in solar masses. The densities tabulated are intermediate between the mean density and the central density.

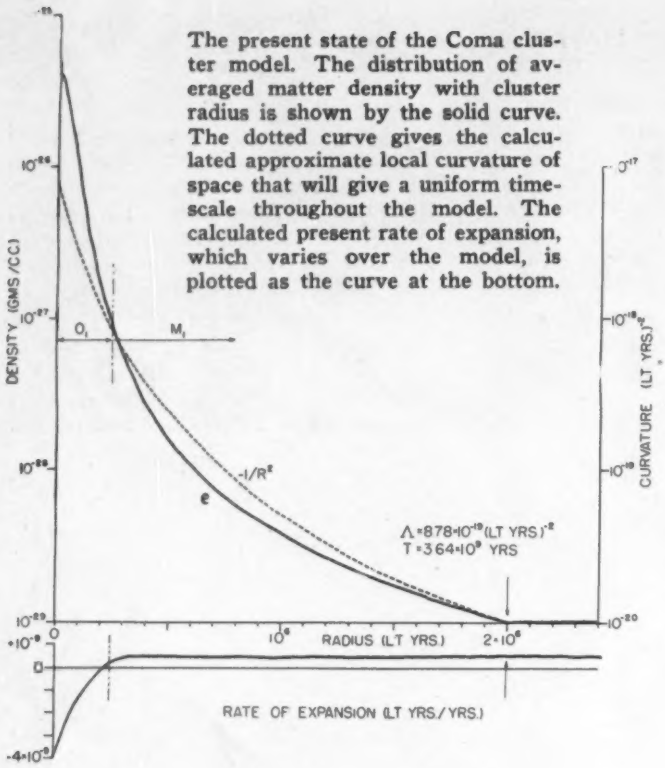
Time	*Density*	*Radius*	*Mass*
−14	1.8	3.8	410
−10	2.2	3.5	390
− 7	2.6	3.3	370
− 5	3.0	3.1	350
− 2	4.0	2.7	330
0	5	2.5	310
2	6.6	2.2	290
4	9.6	1.9	270
6	16.3	1.5	240
7	23	1.3	220
8	39	1.1	200

A Relativistic Model

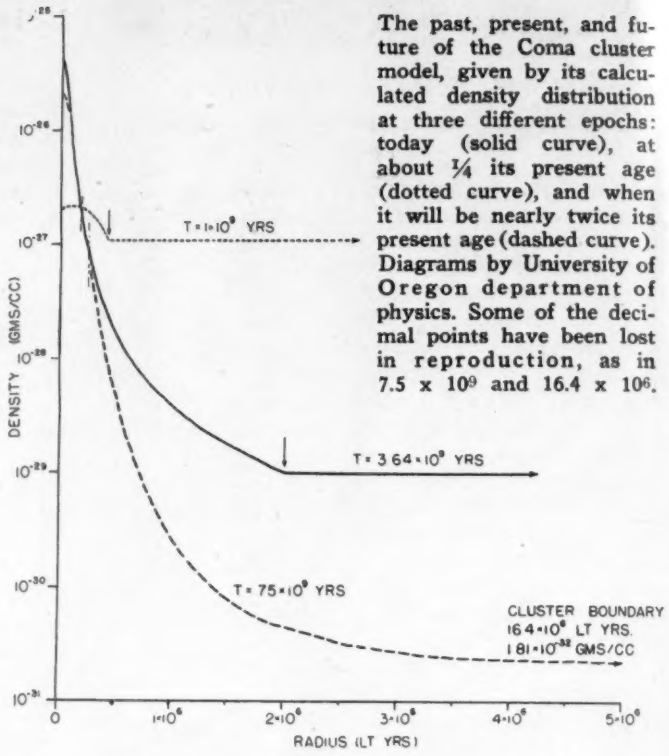
IN EXAMINING the problem of the age of the universe, the tendency of galaxies to form clusters gives important clues, but the interpretation of the observed distribution of galaxies in clusters differs with various investigators. As a continuation of his work reported at Pasadena in June (*Sky and Telescope,* VII, 300), Dr. Guy C. Omer, Jr., now of the University of Oregon, has constructed an approximate numerical relativistic model for a cluster of galaxies, based on the Coma cluster. The cluster is considered as forming the central portion of a cosmological model and as extending out to a present radius of two million light-years. Beyond this boundary, the model is taken as identical with that for which Dr. Omer has already tentatively adopted a time-scale or "age" of the universe of 3,640,000,000 years.

Since the dimensions of the cluster are small compared to the rest of the model, it is reasonable to require that the time-





The present state of the Coma cluster model. The distribution of averaged matter density with cluster radius is shown by the solid curve. The dotted curve gives the calculated approximate local curvature of space that will give a uniform time-scale throughout the model. The calculated present rate of expansion, which varies over the model, is plotted as the curve at the bottom.



The past, present, and future of the Coma cluster model, given by its calculated density distribution at three different epochs: today (solid curve), at about ¾ its present age (dotted curve), and when it will be nearly twice its present age (dashed curve). Diagrams by University of Oregon department of physics. Some of the decimal points have been lost in reproduction, as in 7.5 x 10⁹ and 16.4 x 10⁶.

scale everywhere within the cluster be equal to the time-scale at its boundary. Ten billion light-years has been taken as the radius of curvature of space outside the cluster; then, by imposing the time-scale condition above, the radius of curvature of space within the cluster has been calculated. Dr. Omer has substituted for the usual smooth continuous density distribution curve a kind of "stair-step" curve, each step corresponding to what is known as a Friedmann zone. The steps may be as small or as large as desired, and they permit calculation of the physical properties of points in each zone. The results are plotted and joined with a smooth curve to give a fairly good approximation to the actual evolution of the cluster. This calculated result accounts only for the averaged-out gravitational behavior and does not include the random kinetic theory effects. A complete treatment of a cluster should include both relativity and kinetic theory, but Dr. Omer's interest is primarily in the time-scale and the effect of the expansion of surrounding space upon the cluster — both relativistic effects.

While most of the Coma cluster at present appears to be expanding with the rest of space (although at a slower rate), inside of a radius of 250,000 light-years there is a change in the behavior. Dr. Omer calls this interior portion the nucleus of the cluster, and finds that it does not expand with the surrounding space. It is in an oscillating condition. Thus, the nucleus should persist with time, while the remainder of the cluster expands to nothingness with the rest of space.

A billion years after the beginning of the expansion the cluster would not have been very conspicuous as observed among the galaxies in the sky, its density varying only by a factor of two to one, while the present density range over the cluster is 4,100 to one. The Oregon physicist suggests that such behavior may fit in well with his earlier proposal that a homogeneous distribution of matter in the universe is unstable and that any local tendency for matter to condense is followed by emphasized condensation. Possibly clusters of galaxies have been formed from initial small fluctuations in density at the beginning of the expansion.

To complete his presentation, Dr. Omer calculated the possible state of the model after 7,500,000,000 years, about twice its present age. The nucleus appears quite permanent both in radius and density, but the remainder of the cluster will have pretty well expanded away. But such an extrapolation is to be taken cautiously, as the model is based on assumptions and procedures that may later require considerable modification as more theoretical work is done.

Indexes and Bound Volumes

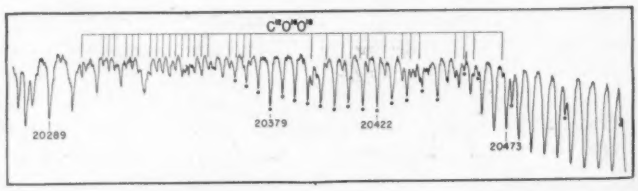
All volumes of **Sky and Telescope** are fully indexed, and the indexes are available at 35 cents each postpaid. Send 35 cents in stamps or coin or include with your renewal check or money order. Bound volumes, at $6.50 each postpaid, are also stocked for Volumes II, IV, V, VI, and VII.

SKY PUBLISHING CORPORATION

Carbon Dioxide Isotopes

INFRARED SPECTRA of the sun studied at the McMath-Hulbert Observatory, University of Michigan, have revealed the presence in the earth's atmosphere of carbon dioxide made up of the less common isotopes of carbon and oxygen. These are carbon of atomic weight 13 (C^{13}) and oxygen of atomic weight 18 (O^{18}); the abundant isotopes of these elements are of weights 12 and 16, respectively.

The isotopes of carbon dioxide, found by Drs. Leo Goldberg, Orren C. Mohler, and Robert R. McMath, are $C^{13}O^{16}O^{16}$ and $C^{12}O^{16}O^{18}$, detected in several relatively faint band structures, one of which is shown in the tracing below made with the all-reflecting spectrometer and Cashman lead-sulfide cell. In view of the difficulties that arise in the comparison of the intensities of very strong and very weak absorption lines, it is not possible at present to derive accurate isotope abundances from the line intensities. But the relative intensities of these carbon dioxide isotopes appear to be consistent with the generally accepted abundances of C^{13} and O^{18}, respectively 1.1 per cent and 0.20 per cent those of the more abundant isotopes of these two elements.



McMath-Hulbert infrared solar spectrum tracings, scaled in angstrom units. $C^{12}O^{16}O^{18}$ is labeled, and the dots mark bands of the isotope $C^{13}O^{16}O^{16}$.

NEWS NOTES

By Dorrit Hoffleit

SKY-BRIGHTNESS PHOTOMETER

In the *Journal* of the Optical Society of America for December, 1948, Dr. John W. Evans, of the High Altitude Observatory of Harvard and the University of Colorado, describes the photometer he has built for measuring the brightness of the sky close to the sun. Such measurements have always been difficult: the scatter by diffraction from the edge of an aperture diaphragm fully illuminated by direct sunlight is many times brighter than the brightness of clear sky near the sun, and is enhanced by scatter from dust on the lens surfaces and multiple reflections between lens surfaces. The system Dr. Evans uses he describes as consisting "essentially of a rudimentary Lyot coronagraph of 3-mm. aperture equipped with an external occulting disk which shades the entrance aperture, and a photometric comparison surface illuminated by direct sunlight through an adjustable optical wedge." For satisfactory results it requires careful adjustment and cleanness of the optical parts. The instrument Dr. Evans uses is restricted to measurements of sky brightnesses less than 500 millionths as bright as the sun. The range can, however, be extended.

NEW BEAM-SPLITTER MIRRORS

Are you interested in mirrors that will transmit half the incident light and reflect the other half? According to a Science Service release, Army engineers at Fort Belvoir, N. J., have improved upon a German version and developed a mirror for use in range finders that will be of great aid in mapping operations. The mirror coatings used are titanium or iron, oxidized by baking. They yield nearly 50 per cent reflection and 50 per cent transmission. Loss of light by absorption is only one per cent when titanium is used and six per cent for iron. With the aluminum coatings ordinarily used heretofore nearly 45 per cent of the incident light was lost by absorption.

SCIENCE IN JAPAN

"A Survey of Japanese Science" is the title of an encouragingly illuminating article by Dr. Harry C. Kelly in the *Scientific Monthly* for January, 1949. It describes particularly the organization along democratic principles of a new Science Council of Japan for the promotion of the development of science and its permeation into administration, industry, and the nation's life.

Dr. Kelly also comments favorably on other postwar Japanese activities for the furtherance of science. In particular, one group has already abstracted for journals abroad some 5,000 papers in physics, chemistry, biology, and engineering which were published in Japanese during the war. The American Institute of Physics and the AAAS are aiding the Japanese scientists by permitting them to translate or reproduce their publications.

MASS-LUMINOSITY DISCORDANCES

In a paper on the masses and mass ratios of close binary systems published in the *Annales d'Astrophysique,* Dr. Otto Struve draws attention to groups of stars that appear to violate to an enormous degree the ordinarily well-defined mass-luminosity relationship. For example, the close pairs known as W Ursae Majoris systems have nearly equal component stars, their light curves indicating a difference of only 7/10 of a magnitude, whereas the mass-luminosity relation and the mass ratios of the pairs would require a difference of three magnitudes. Can the discrepancy be explained by a common envelope through which an adjustment in the outer layers takes place, rendering the components spectroscopically and photometrically more nearly alike than would be consistent with the mass-luminosity relation?

Some Algol-type eclipsing systems are likewise puzzling. Their spectra and light curves indicate absolute magnitudes of +3 while the masses found would require absolute magnitudes of +13! It is important to note that when the spectra of both component stars are observed it is impossible to reconcile them with the masses of both components and with the mass-luminosity relation. Dr. Struve comments, "We should probably recognize that at least the fainter components of the Algol-type binaries are stars of a kind not previously recognized in astronomy. Since they apparently do not occur among visual double stars it is possible that they are abnormal only because they have not had time to recover from the catastrophe which led to the formation of the binary and to adjust themselves to conditions appropriate for their masses. It would carry us too far to speculate further on this subject, except to say that if the adjustment is not now complete there is no stability and hence not even a certainty that the present masses of the components are safe from dissipation." Although slow streams of gas moving around the binary system might account for the discrepancies noted, such interpretations are not yet conclusive.

A third group of discordant systems occurs near the upper end of the mass-luminosity relation—among the stars of high mass. Examples are Plaskett's star (HD 47129) and Pearce's star (HD 698). In the former, however, Dr. Struve found that the intensities of the spectral lines and the radial velocities of the fainter components undergo erratic changes so that the lines cannot be used for the determination of the mass ratio. On the other hand, HD 698 gives a serious discrepancy between the absolute magnitude obtained from the mass-luminosity relation and the magnitude inferred from the hydrogen lines of the spectrum. From the evidence obtained from Plaskett's star, Dr. Struve believes it is possible that a reinterpretation of the measurements of the spectrum of the secondary component is necessary and that the recorded discrepancy between mass and luminosity has been caused by distorted velocity curves.

FREE METEORITE CHECK SERVICE

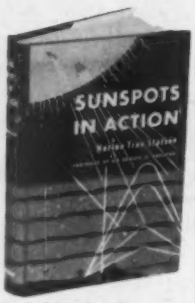
Many people think they have found meteorites when in fact the objects prove to be cinders or unusual terrestrial stones. If you find something you think or hope is a meteorite, send it to the Smithsonian Institution, Washington, D. C. Experts there will examine it for you, free of charge, and tell you what it really is. In case it happens to be a genuine meteorite and a better specimen of its kind than any already in the Smithsonian collection, the Institution may even buy it, reports Science Service.

The Smithsonian collection of meteorites, started about a hundred years ago, contains specimens of 70 per cent of all known meteorite falls in the United States and of over 50 per cent of the known falls of the world.

MYSTERY SOLVED

While our February issue was in press, the November, 1948, issue of the *Monthly Notes* of the Astronomical Society of South Africa was en route with the solution of the quandary about a star suspected by J. V. B. Lourens of being a nearby binary, discussed in this department last month. He now reports that Dr. J. Jackson finds that two independent stars are involved. One is visually 9th magnitude but so very red that photographically it is much fainter than a companion which was visually inconspicuous. The red star is CoD −62° 466 (*Cordoba Durchmusterung*), while the photographically brighter but visually fainter companion is the star CPD −62° 1643 (*Cape Photographic Durchmusterung*). In the Boss proper motion catalogue the star GC 14544 was identified as the CPD star whereas the data given corresponds to the CoD star, which has a spectral class of F0. Thus the mystery is ignominiously solved, and there is no new nearby system.

SUNSPOTS IN ACTION



Harlan T. Stetson

"Dr. Stetson is to be congratulated for gathering together so many kinds of data and information into one compact and readable book . . . Should prove valuable reading for anyone interested in solar and terrestrial relationships . . ."
—Richard A. Craig, Bulletin, American Meteorological Society.

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BOOKS AND THE SKY

THE COMPUTATION OF ORBITS

Paul Herget. Published by the author, University of Cincinnati, Cincinnati, Ohio, 1948. 186 pages. $6.25 (educational and professional discount, 20%).

THE ART of computing orbits for comets and asteroids has, in recent decades, become more and more confined to a small group of specialists. This tendency arises largely from the broadening of the field of astronomy to include more disciplines of thought. But surprisingly enough, the tendency appears to have been intensified by the widespread availability of the table-model mechanical calculators, devices that should have increased interest in the field by reducing the tedium of logarithmic calculation.

The reviewer believes that present-day students of astronomy have less opportunity than their predecessors to learn orbit calculation, mainly because comprehensive texts and collections of relevant tables are unavailable, especially in English. The massive tomes on this subject are beautifully developed — but for logarithmic, not machine, calculation. Even though the automatic "brain" calculators will eventually usurp the field of orbit calculation, the student of modern astronomy will find that a knowledge of the methods of mechanical quadrature and the art of table-machine calculation is invaluable in both theory and analysis.

Paul Herget has made indeed a fine contribution in providing a textbook of orbit computation. It should be welcomed by all instructors in the field, for it is concerned primarily with the teaching of the subject. There are few men who have had as much experience as the author both in computing orbits and in teaching; the results of his experience are passed on to the reader of **The Computation of Orbits** in the form of extraordinarily good notes.

The reader will be impressed immediately with the wealth of material covered in so small a space. Included are: the calculus of finite differences; some spherical astronomy; the two-body problem; the methods of orbit calculation according to Laplace (Stumpff's modification), Gauss, and Olbers; methods of improving orbits; special perturbations; Hansen's method of general perturbations; and seven auxiliary tables — with complete numerical examples of all methods. All within 186 pages!

Such compactness has not been gained without compensating losses. No subtitles are used; formulae are not always collected and are usually poorly identified; numerical examples have no titles or easy identification; the index is sketchy; and the tables are extremely condensed. A further gain in space reduction is made by extensive use of vector notation. This last saving probably should not be criticized except for a general weakness of typewriter font; the vector and scalar quantities are not always distinguished easily.

Readers familiar with orbit computation will recognize the imprint of the author's individuality and experience throughout the volume. Old formulae seem a little different than one remembers them, and are generally improved. Readers unfamiliar with the subject, even though well trained mathematically, will find the book not easy for quick reference. Many students will need guidance in using the text.

Most of the tables have been newly calculated by Herget for machine calculation. The tables to assist in computing positions in nearly parabolic orbits are very welcome, as are those of the Everett even-difference interpolating coefficients for tables of integration.

Notwithstanding its weaknesses (some of which arise from the author's desire to place the book within the budgets of astronomy graduate students), the work should contribute greatly to the continuance of orbit computation in astronomy, particularly to tending the flock of minor planets.

FRED L. WHIPPLE
Harvard College Observatory

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CENTENNIAL SYMPOSIA

Various authors. Harvard Observatory, Cambridge, Mass., 1948. 385 pages. $5.00.

THIS STIMULATING ACCOUNT of recent researches consists of invited papers presented at symposia held at Harvard Observatory in December, 1946, in celebration of the centennial of the founding of the observatory. The papers comprise contributions on interstellar matter, electronic and computational devices, eclipsing binaries, and the gaseous envelope of the earth, particularly the influence of solar radiation upon the earth's atmosphere, and are published as Harvard Observatory Monograph No. 7.

Important results of six-color photometric studies of our own and other galaxies are summarized by Stebbins. In our galaxy the law of interstellar absorption is best determined from observations of the reddening of early-type stars, while the ratio of reddening to absorption is found from the Andromeda nebula. The equatorial bulge in our galaxy is visible in the infrared.

Schalen's interpretation of the colors of the Merope nebula in terms of scattering by small metallic particles seems out of date in view of the evidence in favor of dielectric particles being the principal contributors to interstellar absorption.

Greenstein emphasizes the importance of stars imbedded in denser parts of the obscuring medium — particularly the dwarf T Tauri stars, such as BD −6° 1253, R Monocerotis, and R Coronae Australis, which are closely associated with reflection nebulae. These stars show emission lines of hydrogen, iron, titanium, and calcium, possibly arising from the infall of dielectric particles. R Monocerotis, which is associated with Hubble's variable nebula NGC 2261, shows conspicuous variations. It has sharp hydrogen lines which were stronger in the nebula than in the star when the latter was faint, as though the long light path in the nebula strengthened the Balmer lines. Short-term variations in T Tauri stars may be worth investigation. Ann Arbor spectrograms of R Monocerotis show that on December 1, 1948, the violet and red emission components of hydrogen gamma were of about equal intensity, while the violet component was not visible two days later although the red component remained. Other changes in the spectrum are suspected.

Interesting new possibilities of surface photometry of emission nebulosities are described in a paper by J. G. Baker. The California nebula is prominent on a plate sensitive to hydrogen alpha, and is absent on a photograph covering only the yellow region where there are no strong emission lines. How much of the hydrogen-alpha picture is to be attributed to forbidden NII radiations can be answered only by spectrographic observations. The quantitative interpretation of photometric observations will require knowledge of the target areas for the collisional excitation of the forbidden lines; calculations for the NII lines are now in progress.

H. C. van de Hulst summarizes the important Dutch investigations of the formation and destruction of particles in interstellar space and the resultant size distribution. Spitzer traces the steps whereby clouds of interstellar grains may be formed from the primordial gaseous medium and shows how these clouds may contract to form dense masses akin to the globules, which Bok concludes form observational evidence for star formation going on before our eyes.

Whipple analyzes Adams' data on the radial velocities and intensities of the interstellar gas clouds and finds mean speeds of 35 kilometers per second for large and 10 kilometers per second for the small clouds. He suggests that large clouds are formed by amalgamation of smaller ones. A sketch of how a planetary system might be formed from the collapse of a globule is given but some of the argument (pages 139-140) is hazy and unconvincing. The possibility that the solar system may have been formed in some such way merits further study.

Electronic and computational devices of interest to astronomers are described by Kron, who writes on photocells; Whitford, who discusses important advances in infrared work; and Eckert, who gives an account of measuring, computing, and tabulating devices employed at the Wat-

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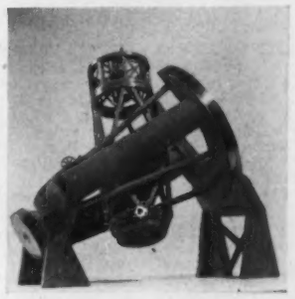

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son laboratory. Kron describes the design of a possible phototube that would be superior to existing commercial cells. Whitford emphasizes the importance of the Cashman lead-sulfide cell, which he subsequently employed in his own work on the law of interstellar absorption in the far infrared (**Astrophysical Journal,** January, 1948), and which Kuiper used in important spectral studies of the stars and planets. This remarkable photoconductive cell makes possible a study of the infrared spectrum of the sun with high dispersion, and an atlas of this spectral region is being prepared at the McMath-Hulbert Observatory. Eckert's account of the punch-card computing and measuring machines will suggest how reductions of vast amounts of astrophysical as well as astrometric data can be handled accurately and effectively. (See also J. B. Irwin, PASP, **60**, 235, 1948.)

The first Henry Norris Russell lecture, delivered by Professor Russell himself, introduces the subject of eclipsing binaries. Struve finds surprisingly large differences in stellar masses in eclipsing systems. R. M. Petrie describes his method of finding the relative luminosities of eclipsing stars from the lines in their spectra. Harlow Shapley calls our attention to the fact that most eclipsing stars in a unit volume are of the W Ursae Majoris type, small objects comparable in size with the sun and with periods of about a day. Kopal enumerates some of the outstanding problems of eclipsing binaries.

It cannot be too often repeated that our knowledge of the fundamental properties of stars, their masses, dimensions, shapes, and internal structures, rests upon double stars and in particular upon eclipsing double stars. The increased accuracy of the photocell over the eye and photographic plate enables us to detect limb darkening and other effects formerly concealed by errors of observation. The need for a modern treatment of the practical calculation of eclipsing binary orbits is acute.

The symposium on the gaseous envelope of the earth includes papers by Goldberg and Menzel on the solar corona and ultraviolet radiation, solar activity (illustrated by motion pictures) by Roberts, and papers on the ionosphere by Dellinger and Stetson. Menzel discusses earth-sun relationships, Whipple summarizes the data supplied by meteors, while Haurwitz discusses the mechanism of the ozone layer. Willett describes possible effects of solar activity on the circulation patterns of the lower atmosphere — which determine the weather.

Goldberg and Menzel show that a good account of the excitation of the corona can be obtained if we postulate that high-frequency quanta are emitted by small areas in or near the photosphere — the so-called hot spots. These regions cannot be cracks through which we see to the deep interior of the sun; possibly high local temperatures are produced in the neighborhood of sunspots by electrodynamical processes. The excitation of the corona may not be due to hot spots entirely. Schwarzschild's shock-wave hypothesis appears to account for a high temperature in coronal regions although the enhancement of FeXIV (green coronal line) near disturbed areas indicates these spots play important roles. Detailed heating mechanisms remain to be worked out.

It is unfortunate that no discussion is given of the important data supplied by spectroscopic studies of the earth's atmosphere, nor of the basic reactions to be expected in the ionosphere and above. Correlations between solar activity and radio reception, although of immense practical value, can never be understood until we have a picture of how the ionospheric layers are produced and how they are disturbed by changes in the sun. Saha, Kiepenheuer, and others have argued for a strong ultraviolet excess in the solar spectrum, while Woolley has attempted to show that black-body radiation at 6,000° K. will account for the ionization. At the present time we cannot be sure which ionization and recombination processes are responsible for the E and F layers (see Bates and Massey, **Proceedings of the Royal Society A, 187,** 261, 1946). Hence we cannot interpret the changing electron densities in terms of variable sunlight in the far ultraviolet.

The influence of possible solar variations upon long-range changes in the circulation pattern of the earth's atmosphere is discussed by Willett, who presents some data suggesting that colder winters tend to occur at times of heightened solar activity. The evidence cannot be taken as conclusive, and it seems possible that terrestrial phenomena such as volcanic eruptions may produce more marked effects upon the weather.

The book is a fascinating research narrative that is recommended to astronomers, physicists, investigators of the upper atmosphere, and particularly to students, who will find here an introduction to some of the most active fields of modern astronomy.

LAWRENCE H. ALLER
University of Michigan Observatory

NEW BOOKS RECEIVED

THE FACE OF THE MOON, *Ralph B. Baldwin,* 1949, *University of Chicago Press.* 239 pages. $5.00.

The author reviews the surface features of the moon, discusses various hypotheses for their formation, adopts the meteoritic as the only tenable theory, and discusses how meteorites formed craters and induced the operation of secondary mechanisms.

SWEEPER IN THE SKY, *Helen Wright,* 1949, *Macmillan.* 253 pages. $4.00.

This biography of Maria Mitchell tells for the first time the interesting story of the first woman astronomer in America, who lived from 1818 to 1889. A native of Nantucket, she became internationally known, and was the first director of Vassar College Observatory, founded in 1865.

ASTRONOMIE, *Oswald Thomas,* 1949, Verlag "Das Bergland-Buch," Salzburg, Austria. 630 pages. No price given.

This is a sixth edition of Professor Thomas' popular text, in German, with 282 diagrams and 38 illustrations.

ENGINEERING THE NEW AGE, *John J. O'Neill,* 1949, *Ives Washburn.* 320 pages. $3.50.

The science editor of the New York *Herald Tribune* tackles the problem of how science and technology can build a better world of tomorrow, including the organization of the "multiman," whose primary purpose will be the advancement of human welfare.

GLEANINGS FOR ATM's

Advantages of a Long-focus Reflector

FOR THE PAST 12 YEARS the writer has built and used many reflecting telescopes, including several of his own construction. It has been increasingly his impression that there is a very wide difference in quality among them. This difference is by no means in the mounting alone, for amateur-made instruments do vary considerably in refinement according to the ingenuity and ability of the builder. The mirror, flat, and eyepiece are the items which really make an instrument good or poor; and it is this, the optical system, in which there are such notable differences. Many an amateur has temporarily mounted his new mirror in a simple fashion to test its optical qualities, and if the instrument really performs well a more pleasing and elaborate mounting is usually begun at once. However, as long as the optics are not the best, the finest mounting will be little improvement as far as critical observing is concerned.

The mirror is really the thing, and the writer has seen a number of beautifully mounted reflecting telescopes as large as 10 and 12 inches aperture which even on fine nights would not begin to give the definition on lunar and planetary detail of which a really good 3-inch refractor is capable. In the last few years a trend among amateurs toward securing refractors of from four to six inches aperture in preference to larger reflectors has become evident.

With the exception of special cases, this trend is because many observers do not appreciate the top performance to be had from a really fine mirror. The writer has several amateur-made 6-inch reflectors which nearly if not completely equal the performance of a good refracting telescope of the same aperture. It is true that refractors smaller than 16 or 18 inches have slightly the edge in light grasp, and it has been proven that under poor seeing conditions aperture for aperture the refractor gives somewhat steadier images.

All things considered, however, the reflector, if it be of excellent quality, will more than please the most discerning observer. A first-class 6-inch reflector will disclose to the experienced observer far more than is generally claimed. Much of the finer detail of Mars, Encke's elusive division in Saturn's outer ring, a dozen of the tiny craterlets on the floor of the lunar crater Plato, are all well within the range of a good 6-inch reflector. Yet few amateurs find their first mirrors capable of such observations, and after building a larger instrument with little more success in seeing critical detail, they are likely to turn to the refractor as the cure for imperfect definition.

The real trouble usually is that most reflectors are made of the popular f/8 focal ratio, and even though such a mirror is the easiest parabola to bring to a figure, a parabola is difficult to approach as closely as necessary for optimum performance; although it has been and can be done, it is the exception rather than the rule in the amateur's first mirror. There is, however, a way out that is seldom given much attention in contemporary books on telescope making; and this is the long focal ratio reflector. Many a poor man strives to achieve the same performance with his f/8 reflector that his wealthier neighbor enjoys with a professional f/15 refractor. If the beginner will essay as his first attempt a 6-inch reflector of about 75 inches focal length (f/12.5) or more, forgetting at least for the time all he has read of the crest of the doughnut and such, in other words, any attempt to parabolize, he will produce a mirror of spherical figure that will perform comparably to any refractor of equal size. It

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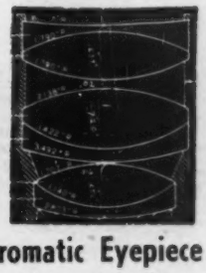

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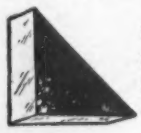

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may be interesting to note in passing that several of the best-known amateur planetary observers prefer the long-focus reflector to the refractor.

The question usually arises, "If I must figure a parabola on an f/8 to bring all the rays of light to the same focus, how can I leave an f/12.5 spherical?" The answer is simply that in small apertures, below 10 inches, at f/12.5 or more, the spherical and parabolic curves so nearly coincide that the sphere can be substituted for the parabola without loss in optical performance. It is also true that a long-focus mirror does not require quite as fine a figure as a short-focus in percentage of suitable correction. The testing of the sphere is easier than of the parabola and this at once should appeal to the beginner, for it makes his first job much easier.* Bad zones or turned edge in either sphere or parabola, however, cannot be tolerated.

The long focal ratio instrument should satisfy the beginner who is usually suffering from a severe case of "high power-itis," when he finds a ¼" eyepiece will give a magnification of about 300 diameters. True, he will learn by experience that he can usually see as much with less power, but this does seem an advantage and occasionally it is. Another and more important advantage is that the secondary elliptical diagonal mirror may be made appreciably smaller than in the usual moderate focal ratio instrument. The advantage of the smaller diagonal is in its reduction of diffraction effects, which greatly tend to impair definition if the minor axis of the diagonal exceeds much more than 1/5 the diameter of the mirror.

There are, of course, a few disadvantages in the long focal ratio reflector; in the 6-inch, however, they are not great. The increased focal length necessitates a longer tube and a steadier mounting. In 10-inch reflectors and larger the long tube problem becomes serious, but a little ingenuity in design and construction will allow portability in the 6-inch size. With the longer tube some type of observing chair or ladder will be found necessary, and provision should be made for rotating the tube in its saddle. Otherwise, if the mounting is equatorial, the eyepiece will assume some extremely awkward positions.

Once completed, the long-focus reflector will more than repay the amateur in performance and definition nearly always missed in shorter focal ratio telescopes. One must build and use a long-focus reflector before its benefits are fully appreciated.

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*Mr. Cave's analysis of the reason an f/12.5 may be left spherical may be summed up as follows: For any mirror, there is a percentage tolerance on the degree of parabolic correction necessary to remain within the Rayleigh ¼-wave limit of optical perfection. This limit reaches 100 per cent at about f/10 and becomes larger as the focal ratio increases. ED.

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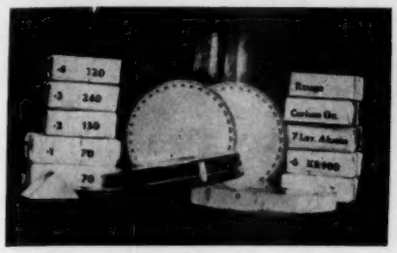

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TESTING AND LAP MAKING

WHILE instructing three high school boys in the art of mirror making, I found it necessary to get a firm and vibrationless support for the mirror and test lamp. The work was being done in an upper flat with considerable traffic past the house. Vibration made it impossible to test until I hit upon the idea of using a long 1" board with the mirror stand on one end and the lamp and knife-edge at the other end. The board is 10" wide. One end rested on a magazine on one table and the other rested on a magazine on another table. There must have been considerable vibration of the board, but the mirror and lamp seemed to move together with no relative vibration between them.

In order to stand the board up in the corner when not in use, I made it in two parts held together with three ¼" bolts, with wing nuts. When two of the bolts are removed the boards can be folded together to shorten the assembly to a more convenient length.

Another scheme I use is in making a pitch lap. This I learned at Howell and Sherburne's shop where I was employed as an optician during the war. We did all of our channeling of the laps with a hot knife. An old machine hacksaw blade about 1" or 1¼" wide and 15" or 18" long was mounted in a soft wood handle by means of a bolt inserted in the blade and in a saw slot in the end of the handle. For further security, and to prevent the blade from swinging around, the end of the handle about the blade was whipped with strong cord. The teeth were then ground off the blade and it was ready for use.

In a Fisher or Bunsen burner flame or over a gas stove the blade is heated until it is warm enough to melt the pitch easily. In this condition it is then drawn over the lap, melting the channels into it. These have been located already by lines scribed in the cold lap with the corner of a razor blade. After each pass of the knife over the lap the pitch adhering must be scraped off the blade by drawing the blade through a slot in a piece of sheet metal mounted on a board. When all of the channels have been cut in this manner the lap is slightly warmed on the surface **only** by passing it at some elevation above and over the gas burner several times, and then it is pressed firmly onto the rouged mirror. This presses down the beads of pitch which have been formed on the edges of the channels by the channeling process. A slight trimming of the facets and edges will then put the lap in perfect shape.

Anyone who has tried this method will never go back to hacking out the channels with a knife or trying to saw them out with a hacksaw. The hacksaw blade used in the above method is usually of tungsten steel and does not lose its spring with heat. Other pieces of good strap steel 1/16" thick might do as well.

Recently, I have found that John Strong, in his book **Procedures in Experimental Physics**, page 48, describes the same channeling blade.

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Please refer to recent issues of **Sky and Telescope** for our advertisement which will reappear in the issue of May, 1949.

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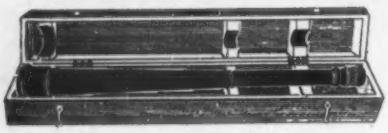

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The Skalnate Pleso ATLAS OF THE HEAVENS, designed and executed by Antonin Becvar and his associates, should prove invaluable to all amateur and professional astronomers. One of the charts, on a reduced scale, was reproduced and described in the November, 1948, issue of *Sky and Telescope*.

The atlas is printed on 100-pound stock, each chart area 15½ by 23½ inches. A title page, descriptive matter and a chart key are included. The set is shipped rolled, in a heavy mailing tube.

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SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Massachusetts

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

The Nodes of the Planets and the Moon

ASCENDING and descending node were two of the symbols reproduced last month for which discussion was postponed until now. These terms apply wherever the planes of the orbits of celestial bodies intersect, particularly in the solar system, where the plane of the orbit of the earth is taken as that to which the orientations of other orbits are referred.

As any planet, asteroid, comet, or meteor revolves around the sun, it is situated either "above" or "below" the plane of the ecliptic. That point in each orbit where the revolving body crosses from south of (below) the ecliptic to north of (above) it is called the ascending node; the point opposite (on the other side of the sun) where the motion is from north to south is the descending node.

When such a planet or other body is at one of its nodes it appears from the earth to be on the ecliptic on the celestial sphere, that is, directly on the yearly apparent path of the sun around the sky. With reference to the sun, the mean longitude of each planet's ascending node is given in the **American Ephemeris**; the descending nodes are each 180° away: Mercury, 47° 43′.6; Venus, 76° 13′.2; Mars, 49° 9′.9; Jupiter, 99° 56′.0; Saturn, 113° 12′.7; Uranus, 73° 44′.1; Neptune, 131° 13′.0; Pluto, 109° 37′.2. These points are all located in a space of less than one quarter of the way around the ecliptic.

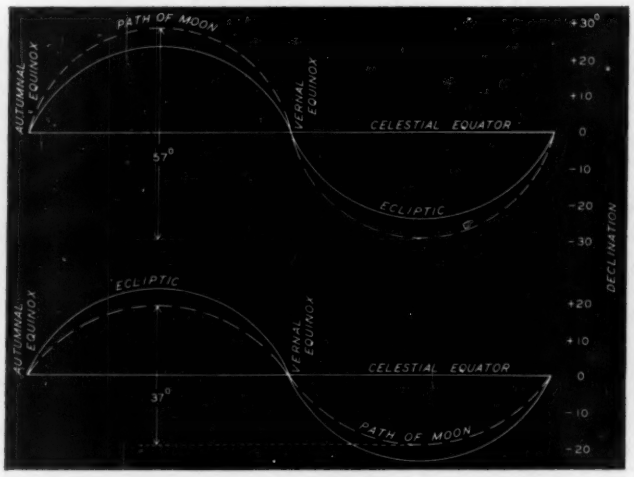
The planet orbits are inclined various amounts to the ecliptic, from Uranus, 0°.8, through Venus, 3°.4, and Mercury, 7°.0, to Pluto, 17°.1. This is the maximum distance as seen from the sun that they can be above or below the ecliptic plane. But at times when the planets are nearest to the earth, particularly in the cases of Mars, Venus, and Mercury, their departures from the ecliptic as seen in the sky may be considerably greater than their respective inclinations. Certain asteroids, comets, and meteors have greater inclinations than the planets and may be seen in regions of the heavens far removed from the zodiac.

In a sense, the equinoxes of the sky are also nodes, for the vernal equinox is where the sun crosses the celestial equator going north, and the autumnal equinox where it crosses going south. As the inclination of the ecliptic to the equator is about 23½° (the obliquity of the ecliptic), the sun's position north and south in the sky can range twice this amount, or about 47° in the course of a year.

The moon's orbit around the earth is inclined 5° 8′ on the average to the plane of the ecliptic, and a perturbation caused by the attraction of the sun makes the moon's place of crossing the ecliptic slide continually westward. A complete circuit takes 18.6 years; this is called regression of the nodes.

When the ascending node of the moon's orbit coincides with the vernal equinox, the moon can range an additional 5° 8′ or a total of about 28½° each side of the equator. Whereas the sun takes a year to reach its extreme north and south positions (thereby producing the seasons), the moon's possible range of over 57° takes place in only 14 days, resulting in a very noticeable variation in altitude when the moon is near the meridian. However, 9½ years later, when the descending node is at the vernal equinox, the 5° 8′ is to be subtracted, for the moon travels between the ecliptic and the equator. The total monthly range is then only about 37°. But at present the extreme range is approaching, for the moon's ascending node is now on the Pisces-Aries border and will reach the vernal equinox in 1950.

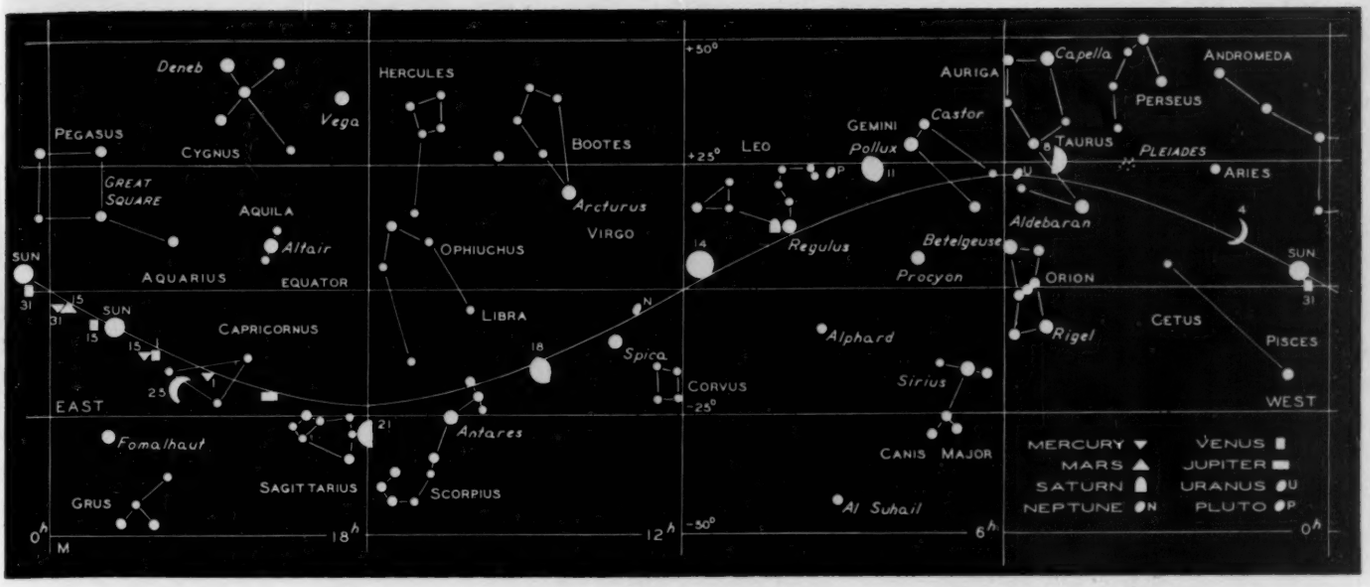
The nodes are all-important in eclipses, for no eclipse may occur except close to the ascending or descending nodes of the moon. Quite often, as this year (April 13th and 28th, and October 7th and 21st), we



The upper half of this diagram shows the situation that prevails when the ascending node of the moon's orbit coincides with the vernal equinox. The moon has its maximum range in declination during each month. The lower part of the diagram shows the reduced range that occurs when the nodes have regressed to the opposite points of the ecliptic.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

have two eclipses in about two weeks, one of the moon and one of the sun at each node. Note these eclipses are nearly six months apart, the time the sun requires to go from one node to the other; an "eclipse season" occurs whenever the sun is near a lunar node.

Next month we shall discuss the April lunar eclipse of the moon in detail, but readers may wish to reserve the evening of April 12-13 to observe a total eclipse of the moon for which Eastern standard times are: first contact with umbra, 9:27.7 p.m.; totality, 10:28.0 to 11:53.8; last contact with umbra, 0:54.1 a.m. Observers in the United States and Canada should have a fine view of the entire eclipse, weather permitting, and the star Spica will be near the moon during the eclipse.

EDWARD ORAVEC

Sun reaches the March equinox on the 20th at 22:49 UT. Spring commences in northern latitudes and autumn in the southern; days and nights are approximately equal over the earth.

Mercury, Venus, and **Mars** will not be visible during March. The first two planets are in the morning sky slowly approaching the sun. Mars is in conjunction with the sun on the 17th.

Jupiter rises about 2½ hours before the sun in the southeastern sky. It is near the Sagittarius-Capricornus border.

Saturn is above the horizon the entire night, the only bright planet visible until just before dawn. Saturn is retrograding (moving westward) and is north and east of Regulus in Leo. See the January issue for information on Saturn's satellites.

Uranus comes to eastern quadrature with the sun on March 17th, setting about midnight. The planet is 4° northeast of Zeta Tauri, and is of the 6th magnitude.

Neptune, of the 8th magnitude, is visible most of the night with optical aid. Its position on the 15th is 12h 55m.3, −4° 10′ (1950). See next page for this year's paths of Neptune and Uranus. E. O.

DEEP-SKY WONDERS

ALTHOUGH many amateurs have equipped their telescopes with good setting circles, and these go a long way toward assisting in a search for deep-sky objects, a finder chart is essential to locate faint objects. With this in mind, this column will carry a series of finder charts showing selected regions of the Beyer-Graff **Atlas.**

NGC 2683, 200[1], 8h 49m.6, +33° 38′, mag. 10.8, 10′ x 1′, Sc. A rather bright spiral in Lynx, aptly termed by Copeland "the forerunner of the galactic host of the spring and early summer." Curiously not mentioned by Smyth or Webb. Very easy to find, as the attached chart shows.

NGC 2781, 66[1], 9h 9m.1, −14° 36′, mag. 12.7, 1′.3 x 0′.4, SBa. A faint barred spiral in Hydra which only the larger amateur reflectors will easily locate. The writer has seen it with a 13-inch, but any trace of cirrus, or too much auroral background will make it invisible.

NGC 2855, 9h 19m.1, −11° 41′, mag. 12.4, 1′.3 x 1′.3, Sa. Another faint early-type spiral which demands optimum seeing. The observer should always use "averted vision" with such faint objects, as a gain of over a magnitude may thus be accomplished. To the east 5m.7 and 16′ to the north lies **NGC 2889,** mag. 12.4, 1′.5 x 1′.5, S. It lies just on the edge of the finder chart and its locating will be good practice in using such charts. Of course this will not be difficult for experienced AAVSO members, most of whom are highly skilled in the use of telescopic charts.

NGC 2811, 9h 13m.9, −16° 6′, mag. 12.5, 1′.9 x 0′.3, Sa. A reference to Norton's **Star Atlas** will show that the brightest stars in this field are within naked-eye reach, just as NGC 2855 has 26 Hydrae on the chart. Hence, although these galaxies are faint, their locations can be accurately determined. With each location correctly known, prolonged observation will reveal an object too faint to be seen by casual sweeps. In fact, study of this area will show many additional faint galaxies.

WALTER SCOTT HOUSTON

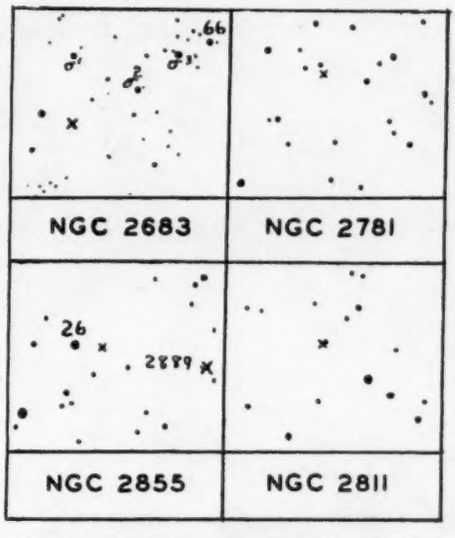


Chart scale is one centimeter to one degree. South is at the top. Star dots are by magnitude intervals; limiting magnitude is 9.

MOON PHASES AND DISTANCE

First quarter	March 8, 0:42
Full moon	March 14, 19:03
Last quarter	March 21, 13:10
New moon	March 29, 15:11
First quarter	April 6, 13:01

	March	Distance	Diameter
Apogee	1d 12h	252,500 miles	29′ 24″
Perigee	14d 21h	221,700 miles	33′ 30″
Apogee	28d 13h	252,600 miles	29′ 24″

CORRECTION

In the information on the moon in the February issue, page 104, instead of diameters, the figures for the moon's horizontal parallax were given. The moon's diameter at apogee in February was 29′ 27″; at perigee, 33′ 20″. ED.

CONJUNCTIONS AND AURORAE

Frank Trathen, of Napa, Calif., writes of his observations in January:

"I observed Jupiter and Venus on the morning of January 26th. They rose at 6:20 a.m. I was rather disappointed for the two planets were separated from each other about the distance of one third the diameter of the moon. I then looked up the data on this conjunction in the **Nautical Almanac** and found the conjunction took place at 8:00 GCT. I observed at 14:20 GCT, making a difference of about six hours. I then realized the speed at which Venus was traveling to have gone this far in that time.

"On the same morning I noticed how far south the crescent moon was located, four degrees farther south than the sun ever gets. It is interesting to observe how far north and south the moon now travels in its 19-year cycle.

"On the evening of January 24th around 8:00 the northern skies were very bright, and I learned afterwards that the northern lights were seen around 10:00 p.m. On the same day there were several very large groups of spots near the solar meridian."

Similar disappointment at the conjunction was registered by J. H. Tanner, of Tampa, Fla., who reports:

"On that particular day, I arose to observe this rare sight, but I needed no optical aid to separate the two planets. In fact, they were at least five minutes of arc apart. Is there an explanation for this rather large error?"

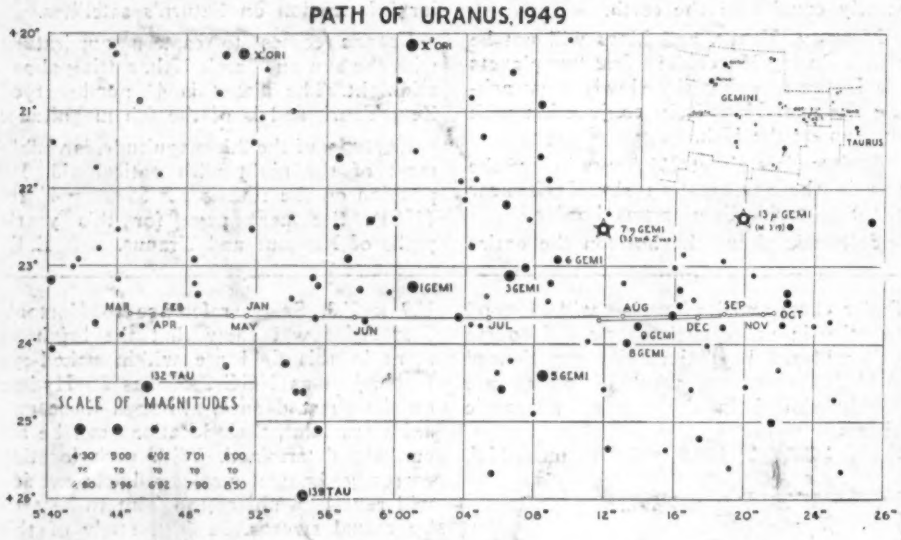
Mr. Trathen already has the explanation, in the rapid motion of Venus, which we underestimated in checking our January material on this planet. The northern lights two nights earlier must have been rather widespread, for from Cleveland, Tenn., Jack West writes:

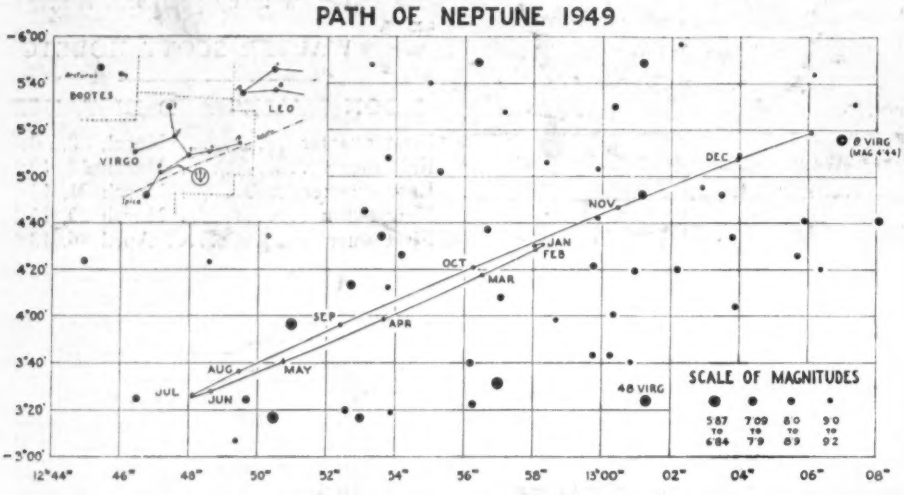
"On the night of January 24th, Cleveland was treated to a beautiful display of northern lights. A large oval cloud first appeared. It slowly changed its shape until it reached a long slender, pencil-like form; then pale white rays appeared just above it. The display began about 7:30 p.m., while I was observing the Orion nebula."

MINIMA OF ALGOL

March 1, 0:50; 3, 21:40; 6, 18:29; 9, 15:18; 12, 12:07; 15, 8:57; 18, 5:46; 21, 2:35; 23, 23:25; 26, 20:14; 29, 17:03. April 1, 13:52; 4, 10:41; 7, 7:31; 10, 4:20.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See Sky and Telescope, Vol. VII, page 260, August, 1948, for further explanation.





The paths of Uranus and Neptune among the stars during 1949, from the "Handbook" of the British Astronomical Association. The fields are inverted, with south at the top, as seen in an astronomical telescope.

OCCULTATION PREDICTIONS

March 22-23 **b Sagittarii** 4.6, 19:53.8 −27-18.4, 23, Im: **E** 11:02.7 −0.5 −1.2 150. Em: **E** 11:35.6 −2.4 +3.4 196.

April 1-2 **Delta Arietis** 4.5, 3:08.7 +19-32.1, 3, Im: **G** 3:37.5 −0.3 −0.8 63; **H** 3:58.6 +0.1 −2.6 120; **I** 3:35.1 −0.5 −1.1 73. Em: **H** 4:43.6 −0.5 +0.8 213.

April 4-5 **136 Tauri** 4.5, 5:50.1 +27-36.1, 6, Im: **A** 3:56.0 −0.1 −1.0 80; **B** 3:52.9 −0.2 −1.0 75; **D** 3:54.0 −0.2 −1.2 86; **E** 3:57.3 −0.2 −1.8 110; **F** 4:19.4 +0.8 −3.4 152; **G** 3:23.9 −1.0 −1.8 106; **I** 3:17.2 −1.2 −2.1 117. Em: **A** 4:48.7 +0.5 −1.4 290; **E** 4:56.0 −0.1 −1.0 262; **F** 4:55.5 −1.3 +0.8 222.

April 15-16 **Alpha Scorpii** 1.2, 16:26.3 −26-19.2, 17, Im: **A** 6:41.2 −1.5 −0.1 120; **B** 6:39.6 −1.4 +0.1 117; **C** 6:35.7 −1.2 −0.3 132; **D** 6:32.4 −1.1 0.0 127; **E** 6:25.2 −0.2 −0.8 155. Em: **A** 7:59.2 −1.9 −0.3 280; **B** 7:56.4 −1.7 −0.3 283; **C** 7:50.3 −2.1 0.0 271; **D** 7:46.1 −1.8 +0.1 276; **E** 7:20.4 −2.3 +1.2 253.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, all data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your own standard time.

VARIABLE STAR MAXIMA

March 2, S Gruis, 7.8, 221948; 4, U Ceti, 7.5, 022813; 10, R Geminorum, 7.1, 070122a; 11, T Normae, 7.4, 153654; 14, R Centauri, 5.9, 140959; 14, R Draconis, 7.6, 163266; 16, R Aquilae, 6.3, 190108; 20, S Carinae, 5.7, 100661; 22, R Leporis, 6.7, 045514; 24, RT Cygni, 7.4, 194048; 24, RU Sagittarii, 7.2, 195142; 28, S Hydrae, 7.9, 084803. April 2, R Virginis, 6.9, 123307.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of March, respectively.

STARS FOR MARCH

WEST of the meridian the sky of early evening in the spring seems far brighter than that to the east, but Arcturus and Spica already are adding their sparkle to bring more balance to the scene. Along the meridian of this month's chart are several fainter star groups which are thus favorably placed for identification by the assiduous stargazer.

Lynx is in the zenith for the observer at 40° north latitude, its stars not nearly so difficult to discern once Alpha Lyncis is located making a triangle with two of the feet of Ursa Major. From this point the stars of Lynx lead to the northwest to the more difficult Camelopardalis, which lies in what at first seems a void region of the heavens.

Cancer, the dimmest constellation of the zodiac, is easy to trace only on a dark night, when it resembles an inverted **Y**, with the cluster Praesepe — the Beehive — located nearly between the stars Gamma and Delta Cancri. To the other side of the 1st-magnitude star Procyon is Monoceros, on whose back rides Canis Minor. Monoceros is an important region of the Milky Way, containing many remarkable star clusters.

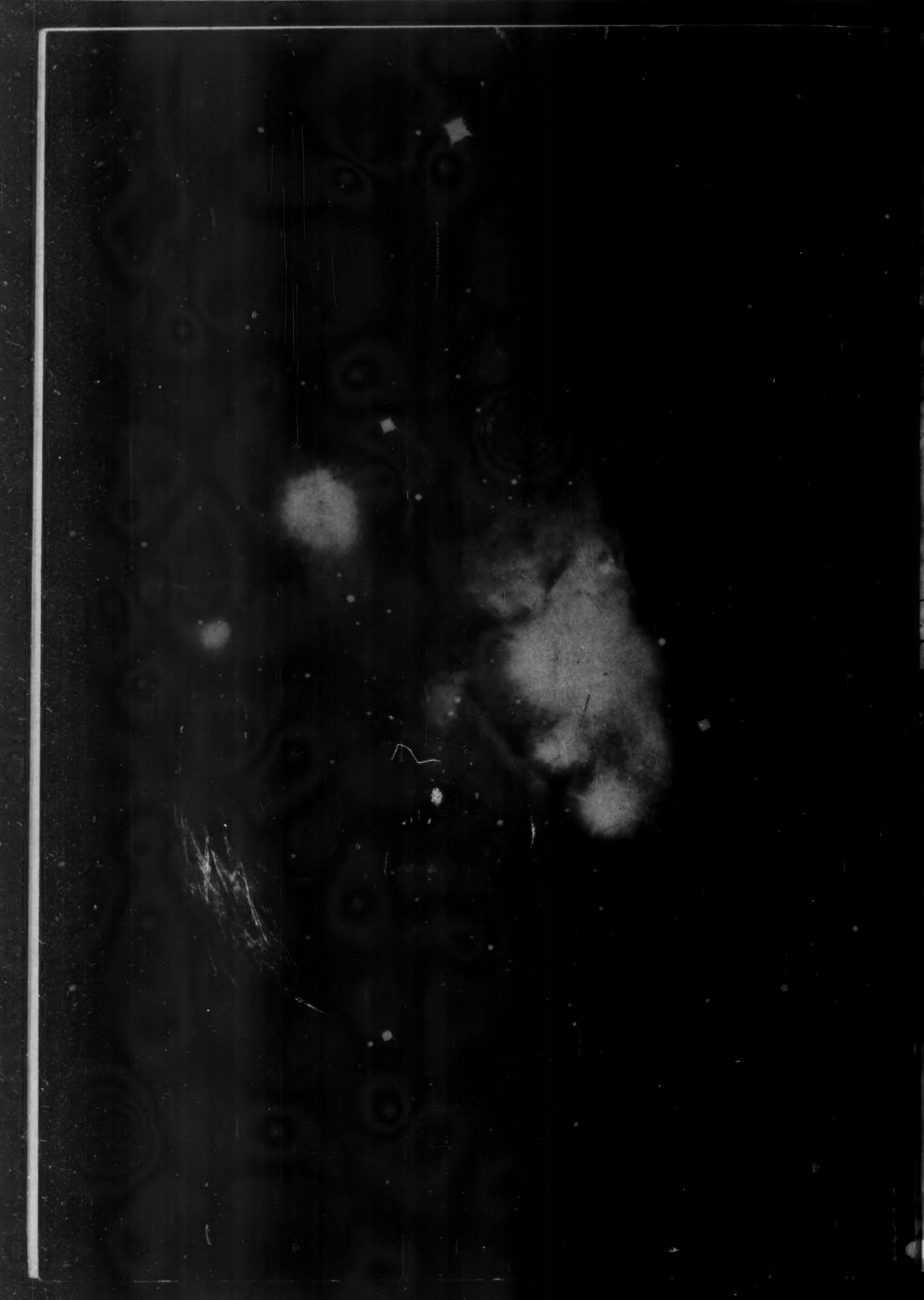



Chart Correction: Bellatrix, in Orion, should be Gamma instead of Beta.